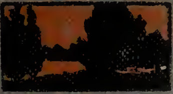
ELEMENTARY INDUSTRIAL

ARTS



WINSLOW

ELEMENTARY INDUSTRIAL ARTS

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"Back of the Brawn, the Brain"

ELEMENTARY INDUSTRIAL ARTS

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PREFACE

In spite of the fact that industry has ever been a most important factor in our national life, it is only within the past few years that instruction in it has been given an amount of emphasis at all commensurate with social demands. New ideas regarding the aims and purposes of education are to-day bringing about long needed changes in subject matter and in the methods of its presentation, while school courses are being reconstructed that they may more effectively meet the demands being made upon them from the outside.

A vast body of industrial information with which all men and women of true culture should

be familiar, is to-day being collected, organized, evaluated, and crystallized into a new school study, a study of industry from the social as well as from the material side, a cultural study with the emphasis upon the how and why of industrial operations combined with a real appreciation of industrial life.

The industrial arts point of view accepted, we shall see that for the purpose of organization most of the drawing, art, and construction work done in schools will fall to the new subject of industrial arts not because it is a *manual* subject but rather because it is an *industrial* subject and because industry deals more directly with drawing and construction than do history or geography. As phases of school life, drawing and manual training are at the disposal of all school studies, but the time has gone by when either drawing or manual training should be regarded as an elementary school subject.

The making in school of paper boxes or of envelopes may be regarded as a good exercise, but the amount of good to be derived from such work is not to be compared with that gained through the making of these and other articles in connection with a study of the industries which they represent. As regards elementary education, we may truthfully say that construction should not exist for mere construction's sake any more than art should exist for art's sake.

Elementary instruction in the industries will create in boys and girls a sufficient interest in and knowledge of things industrial to enlarge their ability to appreciate and enjoy the works of artist, mechanic, and manufacturer. Such an ability will be brought about (1) by investigating the conditions under which products are made; (2) by making drawings to illustrate forms, facts, and operations, thus clarifying industrial concepts; (3) by manipulating the materials from which articles are made, thus creating a new product; (4) by making decorative designs to enhance the beauty of objects.

The subject matter involved in work of this kind is perhaps the most important consideration. The manual work must be made valuable by being made significant. The manipulation of materials whether concerned with representation, with design, or with construction, in most instances will be undertaken for the purpose of clarifying ideas regarding subject matter directly related to the industries.

The study of a particular industry should be approached from the standpoint of general education, the activities involved being adjusted to the ability of the pupils. An industry once chosen for study, the pupils can be put to work investigating it, collecting information from all sources available. Much will be obtained through actual contact with those engaged in the industry

or who handle its products. Some facts will be gleaned from reference books. The topics to be considered will depend upon the information available and the ability of the class. The following will be helpful to the teacher who desires to know what may constitute the subject matter: (1) the value of the industry to man, how we are affected by it; (2) the evolution of the industry, its story, its heroes of invention (history); (3) characteristics of the product, what constitutes excellence; (4) materials employed, where they come from (geography); (5) processes involved; (6) tools used; (7) the training of the workers; (8) the part played in the industry by arithmetic; (9) the part played by drawing and design; (10) references to the industry found in literature; (11) the industry as depicted in art.

The present volume aims to provide instruction in the industries appropriate for boys and girls in the upper elementary grades. It attempts to combine the related drawing and art with construction and this drawing and construction with an industrial subject matter, something which heretofore has not been attempted in a work of this kind. It is most important to-day that pupils in the schools become acquainted with the industries by which man lives. This will help them to a better understanding of life outside of school and of most of the subjects considered in school.

Industrial intelligence is made up largely of a knowledge of processes and of products. This is most easily attained through actually experiencing the difficulties involved in the handling and transforming of materials. It is therefore desirable that the pupils carry out the activities described or suggested in each of the chapters that follow. If this is impossible a careful study of the processes described and illustrated will be valuable.

The author desires to acknowledge indebtedness to his former teachers, Frederick G. Bonser and Mrs. Lois Coffey Mossman, for information and inspiration received in their classes in industrial arts education at Teachers College, Columbia University. The text attempts to carry out in the schools the principles underlying the teaching of art and industry presented in Dr. Bonser's *Some Fundamental Values in Industrial Education*. It aims especially to conform to his definition of industrial arts as "the distilled experience of man in his resolution of natural materials to his needs for creature comfort, to the end that he may more richly live his spiritual life."

For helpful suggestions and criticisms rendered by individuals, publishers, and industrial concerns the author wishes to express gratitude and appreciation. Thanks are due especially to his wife, Lois Crawford Winslow, for general assistance in arranging the copy and for compiling the bibliographies at the ends of the chapters; to

August P. Gompf for material dealing with metals and for assistance in the preparation and revision of the manuscript; to Leila Mechlin, Henry T. Bailey, Gerrit A. Beneker, May E. Greenman, and Mrs. Stuart T. Todd for information relating to art illustrations; to Edwin B. Richards, Ernest Hesser, and Mary B. Hyde for information relating to the source of poems; to William Noyes for material dealing with lumbering and woodworking; to Charles F. Binns for the definitions of pottery products; to Herbert Hutchinson and Harry Hostetler for information dealing with woodworking and soap making; to the *Industrial Arts Magazine*, the *School Arts Magazine*, and the *Manual Training Magazine* for permission to use printed matter and illustrations prepared by the author and appearing first in their columns; to The Macmillan Company for suggestions and for illustrations used in other of their publications on art and industrial subjects; to Louis A. Bacon for illustrations and material dealing with table construction; to Royal B. Farnum for illustrations and material dealing with bird houses; to Augustus F. Rose for illustrations of processes in copper working contained in his book *Copper Work;* to George J. Cox for illustrations dealing with pottery; to James Chittick for reading the chapter on Textiles; to Lina Eppendorff for illustrations and material dealing with beadwork, contained in her *Handwork Construction;* to the American Museum

of Natural History for material and illustrations on Indian beadwork; to the American Type Founders Company for reading the chapter on Bookmaking; to Charles F. Binns and the Rookwood Pottery for reading the chapter on Pottery; to the Portland Cement Association for reading the chapter on Cement and Concrete; to the Anaconda Copper Mining Company for reading the chapter on Copper; to the Butler Paper Corporations for reading the chapter on Paper; and to the many others who have contributed so generously of their time and talent to the success of this book.

Leon L. Winslow

The University of the
State of New York
May, 1921

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ELEMENTARY INDUSTRIAL ARTS

Vesper L. George

Elementary Industrial Arts

I

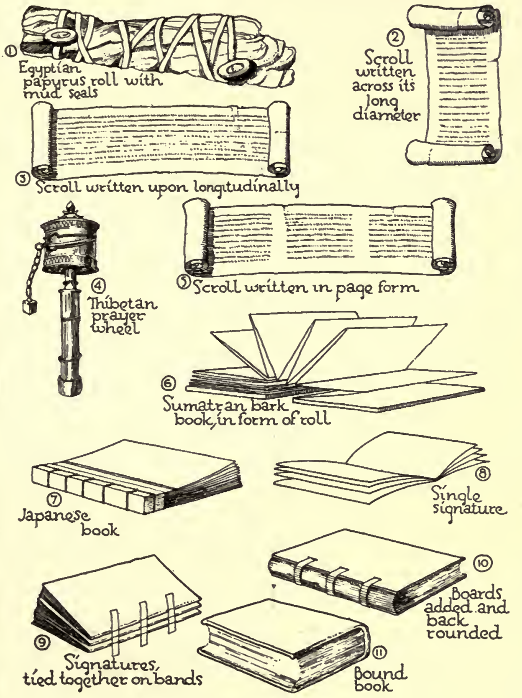
BOOKMAKING

The early Babylonians and Assyrians had no books, but their writings were preserved in the form of *clay bricks*. The writing was inscribed upon the bricks while the clay was still soft. Later the bricks were baked in the sun or sometimes in fire. The Romans used *sheets of soft metal* and *wooden slabs coated with wax* as writing materials. The Chinese employed the bark of the bamboo for the purpose until about 600 A.D., when they succeeded in producing a material resembling our modern rag paper. They kept this secret to themselves, however, until the eighth

century, when the Arabs learned of it and introduced paper making into Europe.

The earliest permanent manuscript writings were inscribed upon *scrolls* which consisted of long strips of *papyrus* or *parchment* rolled upon sticks. These rolls were first held vertically for reading, but later they were read horizontally, or from end to end. Still later, shorter lines were used in the inscriptions, the mass of written characters being broken up into small oblong shapes which somewhat resembled page divisions. This dividing of the inscribed material into sections must have suggested the idea of folding the scroll between these divisions. At any rate the strip of papyrus or parchment was later folded backward and forward, giving it somewhat the form of an unbound book. The back edges later came to be tied together and in this way reading was made much easier and the rolling and unrolling of the scroll in reading were avoided. The idea was carried still farther by the Japanese who laced together the back edges of the pages of their *books*.

The art of bookbinding is much older than the art of printing. We find that the Babylonians provided clay cases for their inscribed clay tablets; the Romans made cases for their early manuscripts. The ivory cases of the double folded wax tablets of the second and third centuries A.D. should be mentioned in this connection on account of their beautiful carved decorations. They are



Evolution of the Book

among our most cherished examples of the Christian art of that period.

In the early days of Greece and Rome, manuscripts in scroll form were copied by scholars known as *scribes*. Books were later made and preserved in the monasteries by the monks who were our first real bookmakers. Some monks spent their entire lives in copying. Their monasteries were to be found all the way from Ireland to Jerusalem. Thomas Bailey Aldrich has written a poem about the monastic scribe, *Friar Jerome's Beautiful Book*. Reading it gives one a feeling of intimate acquaintance with a bookmaker of the middle ages.

The early manuscript books of the middle ages were for the most part gospels and psalters, gorgeously decorated in brilliant colors. St. Boniface, a monastic scribe, once wrote a letter to a friend in which he expressed the wish that his illuminated inscriptions might be gay and bright, "even as a glittering lamp."

Dageus, an Irish monk, skilled in bookbinding, illuminating, and the working of metals, made many beautiful designs for the covers and clasps of his books. Ethelsold, another monk, made, from metal, book covers which were brilliantly gilded and jeweled. Such books were bound in oak boards and these covered with leather and metal. They were often provided with clasps, corners, and other trimmings, which served both a useful and a decorative purpose.

Bookbinders became more and more extravagant in their materials. In 1583, Henry III of France was forced to decree that civilians must not use more than four diamonds in decorating a single volume. The nobility were prohibited from using more than five for this purpose.

Grosset & Dunlap

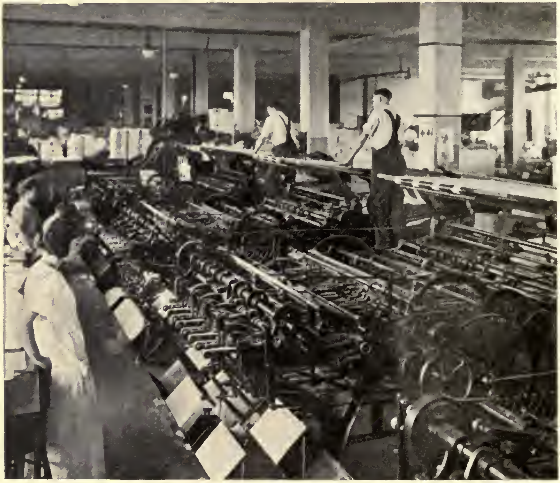
CUTTING DEPARTMENT

The sheets are cut by machine and are stacked and loaded on the truck by the workers.

The early printers were their own binders. Later the binding of books was handed over to stationers. William Caxton, the first English printer, bound his books in covers of tooled leather. His decorative patterns were usually made up of diagonal lines, the diamond shapes formed by the lines being filled by a dragon form. In the sixteenth century bookbinders began to use

damask, satin, and velvet. Bindings of to-day are of paper, cloth, and leather. The cloth binding is an English invention which came into use about 1832.

There are two stages in the modern process of bookmaking. The first includes the writing of



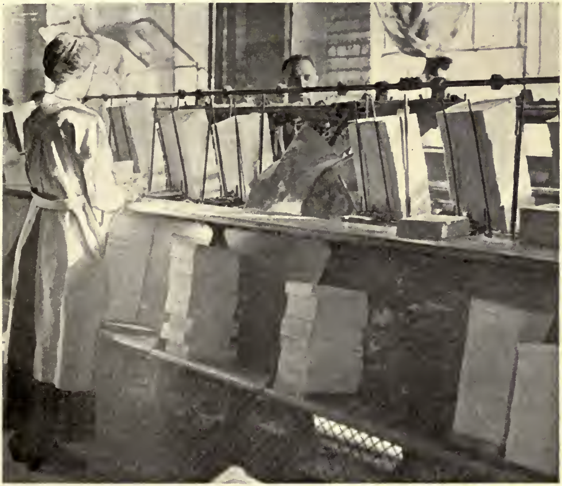
Grosset & Dunlap

The flat sheets are cut and folded into signatures by this machine.

the manuscript and the arrangements between the publisher and author; the second, the overhauling of the manuscript by the printer's reader and the printing of the corrected manuscript.

In books of usual size, thirty-two pages are printed at one time on a single sheet. The types

are so arranged on the press that when the sheet is cut and folded the pages follow one another in numerical order. The thirty-two-page sheet is cut into two sections called signatures.



Grosset & Dunlap

The signature gatherer is almost human; it picks up the signatures in the order in which they are to appear in the book.

A signature consists of sixteen pages, and the ordinary book is composed of from twenty to twenty-four of these. A marvelous machine with mechanical hands gathers the signatures in their correct order.

But there are many steps before the book is

ready for the reader. For instance, there is the matter of illustrations, which takes us back to the artist's original drawing, done in colors or in black and white. The drawing is photographed

Grosset & Dunlap

The gathered signatures are sewn together on this machine.

and a zinc or copper *plate* made of it. If the illustration is to be reproduced in colors, a plate must be made for each color, and the paper run through the press a corresponding number of times. A *zinc etching*, or reproduction in black and white, and a *halftone*, or reproduction in various values of gray, go through the press only

Grosset & Dunlap

The stitched book, rounded and backed, is ready to receive the cover.

once. A zinc etching is used in printing a *line cut* illustration.

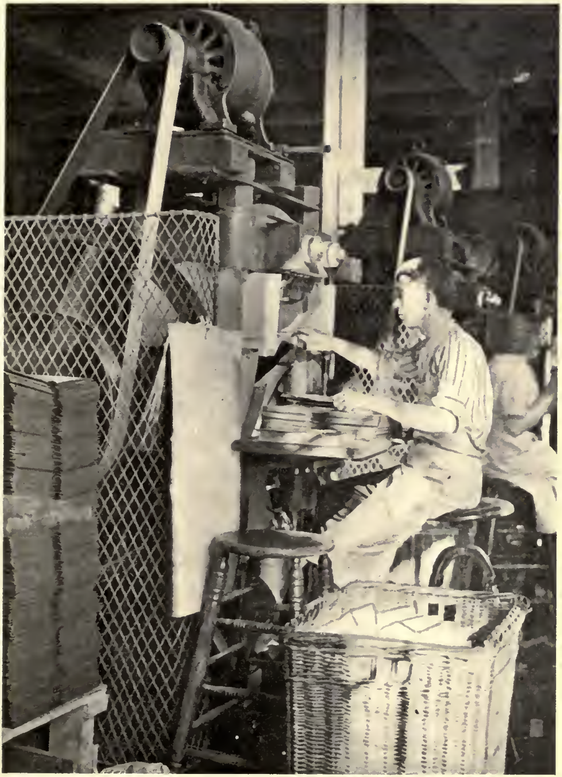
Before and after sewing, in order to make the book lie flat, it is *smashed*, that is, compressed,

Grosset & Dunlap

Completed Books Ready for Shipment to Schools and Book Stores

in a machine exerting several tons of pressure, to squeeze out all the air. Sewing machines stitch the signatures into the composite book. These are fed to the machine, sixteen pages at a time, by an operator possessing considerable skill. Trimming follows smashing and sewing.

Another machine *rounds* and *backs* the book;



Grosset & Dunlap

This machine prints or embosses the cover.

that is, gives it the usual curved back and edge. A back strip is then glued on the unbound book, which is now ready for its cover or *case*. The cover goes through several processes. First two boards, cut the required size, are fed with the cloth into a machine that wraps and glues the cloth to them.

The covers are then placed about the pages and glued fast, after which the book is placed in a heavy press where it remains for at least twelve hours.

A folio is a book which is made from sheets which have been folded once, each sheet forming two leaves or four pages. A quarto is a book made from sheets which have been folded twice, each sheet forming four leaves or eight pages. An octavo is a book made from sheets which have been folded three times, forming eight leaves, or sixteen pages. In making up or assembling a book of many signatures, each sheet in consecutive order is taken from the proper pile, folded, and stitched. Then the assembled sheets are glued and placed in the case along with the other signatures as indicated above.

The great industry of bookmaking can only be appreciated by making a careful study of the slow processes of ancient times and of the evolution which has brought about our modern methods of production.

Just how printing was invented is a fact which has not yet been definitely learned. It is thought

by many who have made a study of the art that the stone seals used by ancient peoples may have suggested the idea of printing. They were often made from precious gems and were *intaglio*, engraved or cut in, an intaglio being the reverse of a *cameo*, which stands out in relief. It was but a step from printing upon wax with a seal to printing upon a harder material with an engraved block. Visiting cards are to-day printed by means of intaglio plates by the process commonly known as *engraving*.

The Chinese were probably the first people to print. Engraved wooden blocks were used in China for the printing of books as early as the sixth century A.D. Printing was unknown in Europe at that time, however. A new application was to be made of it in western Europe by John Gutenberg, a German, about the year 1440.

Gutenberg's printing shop was quite different from our modern printing establishments. The first printing which he did was by means of blocks of wood on which he had carved illustrations and letters in relief (cameo). One of the illustrations engraved by an earlier printer was a picture of St. Christopher bearing the Christ child across a stream.

Gutenberg's discovery consisted in making type from antimony and lead. He succeeded in casting each metal letter by itself, making it possible to arrange the letters as he saw fit. In this way the

same types could be used over and over in limitless combinations as they are used in printing to-day.

It is interesting at this point to recall that the Chinese had long before invented the process of printing. The method of printing with movable types has never been popular in China, however, owing to the almost limitless number of the characters which are employed in the written language of the Chinese. These signify words or ideas, not letters as in our language. China has excelled in her wonderful wood block prints, many of which are still regarded as masterpieces of industrial art.

John Gutenberg's discovery soon bore fruit in England, where, in 1476, William Caxton set up a printing press at the sign of the Red Pale at Westminster. To Caxton belongs the credit of publishing the first book printed in the English language, a translation of *The Recuyell of the Historyes of Troye.*

Both Gutenberg and Caxton employed a *screw hand press* equipped with a *flat bed* upon which the metal type was placed. Pressure was applied by means of a vertical screw turned by a bar. Such presses were at first made entirely of wood.

About 1800 a press was introduced in England in which a *cylinder* was substituted for the *platen,* or flat bed. This cylinder carried the paper over the type, pressing it down to receive the inked impression.

Mathey *Braun & Cie.*

Portrait of an Engraver

The flat bed press was the only one used to any great extent in the United States until about 1865, when William Bullock, of New York,

American Type Founders Co.

Hand Composition

constructed a *rotary press* which printed from an "endless" roll of paper. In 1847, R. Hoe & Co., of New York, produced a press in which the type was on the surface of a revolving cylinder. In 1871, the same concern placed upon the market a

rotary press which printed on both sides of the paper from curved *stereotype plates*. Our modern city newspaper presses are similar to the original rotary machine of R. Hoe & Co., although the mechanism has been constantly improved.

The setting of type in regular order for printing is called *typesetting* or *composing*. Typesetting

Katherine M. Stillwell *Rand McNally & Co.*

The composing stick is held in the left hand.

is to-day performed by hand and by machine. In the hand method the type is placed in a shallow drawer which is divided into small compartments in which all letters or figures just alike are kept, the letters being so arranged that the type is most convenient for the *compositor*, who stands in front of the type case with the *copy* before him. He holds in one hand a little iron tray

called a *composing stick* and with the other he picks out the type and places it in the composing stick. As fast as the composing stick is filled he places the type which he has thus arranged in a *galley*, which is a long iron slip or tray. In book printing the *proof* is taken direct from these galleys. The impression taken from the type thus set is called the *galley proof*. As soon as the proof has passed the inspection of the author, it is returned to the printer, who breaks his galleys up into page divisions and *locks* them securely in the *forms*. The second proof taken is usually the *page proof*. The proofs are corrected again and again and new proofs made until a final one is taken which is at last returned to the author for his final correction and approval. When this has been done the forms for printing one side of a sheet used to form one signature are locked securely in place in a strong iron frame called a *chase*.

American Type Founders Co.

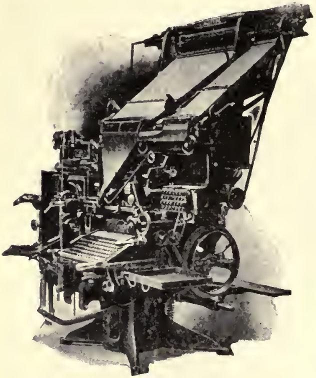
Proof Reading

In modern printing offices, type is for the most part made by means of the *linotype* machine, which

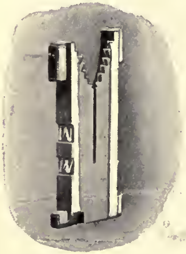
American Type Founders Co.

Arranging and locking types in the chase for printing is called *imposing*.

at one time casts the letters and spaces for a line. In this machine the type is automatically cast in type metal (antimony and lead) by means of *matrices*, or patterns, which form a part of its mechanism. In establishments where quality of work is the chief consideration the type is usually still set by hand. Hand composition makes possible a more artistic spacing of words.

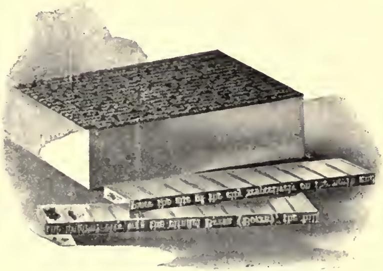

The Linotype Machine

The composing machine known as the linotype was invented in 1886 by Ottmar Mergenthaler, and the first one to be used commercially was installed in the composing-room of the *New York Tribune* in July of that year.


Linotype Matrix

The linotype, which is operated by one or more keyboards similar to the keyboard of a typewriter, is based on the idea of forming the

entire line as a unit in place of the single type unit established by Gutenberg. This entire line,



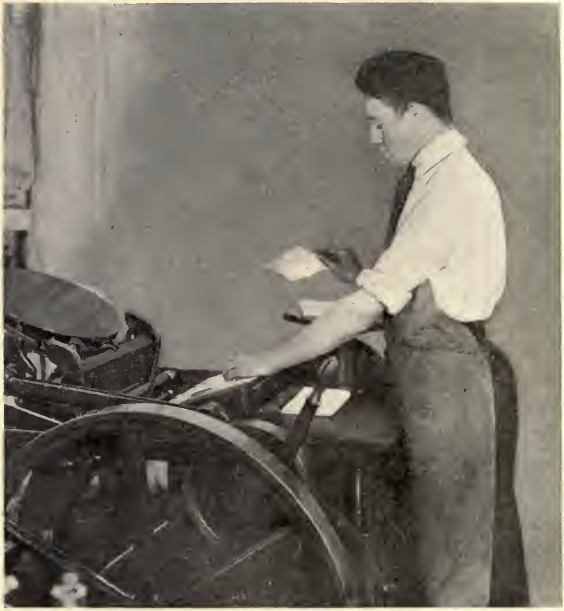
Linotype Slugs

or linotype *slug*, is made by bringing together such matrices (intaglio types) and *spacebands*, or *spacers*, as are required for a line, and then holding the assembled molds in position for casting while molten metal is pumped into the mold and against the face of the line of matrices and spacers. When the machine has completed a revolution the linotype slug is pushed out.

Handling Slugs

The matrices and spacebands in use on a linotype machine can be used over and over again

continuously. As many as three lines of matrices and spacebands can be in movement on the machine at one time; that is, one line can be *assembled*



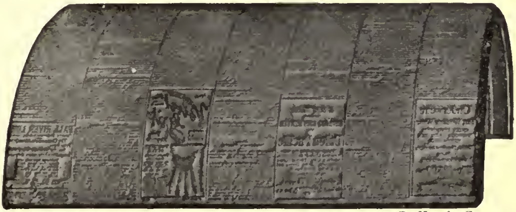
American Type Founders Co.

Press Operating

or put together while another is in casting position, and still another is being distributed. After the slugs have been used once, they can be returned

to the melting pot and the metal used for the making of other slugs. It is of interest to know that linotype matrices now may be had for forty different languages, while American-built linotype machines are now in operation in sixty-three different countries.

When only one edition is wanted, as in the case of small job work, the printing of a book is generally done directly from the type; and after print-



R. Hoe & Co.

A Stereotype Plate Curved to Fit the Press Cylinder

ing, the forms are torn down and the type distributed in the trays for future use. When later editions are likely to be called for, *stereotype* plates are sometimes made. In this way the original type arrangement can be preserved. Stereotype plates are cast in cylindric form for use on the rotary presses employed in newspaper work. *Electrotype* plates are generally used in book printing which is done on a flat bed.

Stereotype plates are made of type metal which is composed of tin, lead, and antimony. The

plates are made by pressing a prepared pulp of wet papier-mâché upon the face of the original type. When this pulp has taken the *positive* impression from the type and has become dry, molten type metal is poured over it to the required thickness. The plate thus formed is fixed upon a wooden block making it of the same thickness as the type stems, in order that it may be placed in the forms and the chase along with the type.

In the process of electrotyping the impression is taken by placing over the face of the original type a sheet of wax which has been heated to the proper degree of softness. When this wax positive impression has been taken, the sheet of wax is placed in a liquid through which passes an electric current, which deposits a thin coat of copper over the wax. This thin copper sheet conforms to the letter shapes. It is now taken from the wax and is backed up and made strong with type metal. The *electrotype* plate at this stage resembles the stereotype plate used in newspaper printing except that it has the outward appearance of being made of copper. Stereotyping is quicker and cheaper then electrotyping. Electrotyping is more durable, however, and is better suited to high-class printing on the finer grades of paper.

Printing is commonly accomplished by steam and electric power, the paper being fed in at one end of a machine and turned out a finished *printed* product at the other, in the case of magazines and

newspapers often at the rate of one hundred thousand copies an hour. When we stop to compare the early methods of printing with the methods employed to-day, we marvel at the wonderful advance in this industry, which has made knowledge easily accessible to us all.

Teacher's Note: If possible, a visit to an up-to-date newspaper or publishing house should be arranged. The instructor may illustrate the process of stereotyping in the following manner: (1) Obtain a linoleum print block which has been made by a pupil, or make such a block by cutting a letter in relief. (2) This block will be the pattern from which it is desired to make a matrix, or form for casting type. Pack pulp (made by soaking paper in water) around the block in order to get an accurate impression of all, including the letter and entire block. (3) Remove the print block from the pulp which has now been made to conform to its shape. (4) Allow this pulp box or matrix to dry. (5) Pour molten lead into the matrix. If poured very slowly the metal will run down into all the edges of the inside of the form. (6) After the lead has hardened and cooled the pulp may be scraped off. (7) The face of the piece of type thus cast should now be finished with a file.

I

The Making of a Simple Booklet

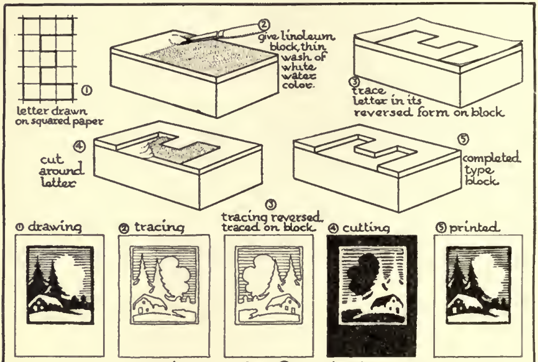
A simple booklet may be made in which to preserve our essays, drawings, and collections. The construction of the booklet need not be elaborate. The pages, perhaps 7 inches by 9 inches in size, are fastened together by punching and lacing. A piece of flexible paper will serve as a cover. A simple cover design appropriate to the subject of printing is made. This design will include

(1) A marginal line.

(2) The title and the name of the author in free hand lettering.

(3) An appropriate *spot* or *unit* which may symbolize a printing press, a printer at work, or a shelf of books.

The design for the unit will be transferred to a



Cutting blocks for printing

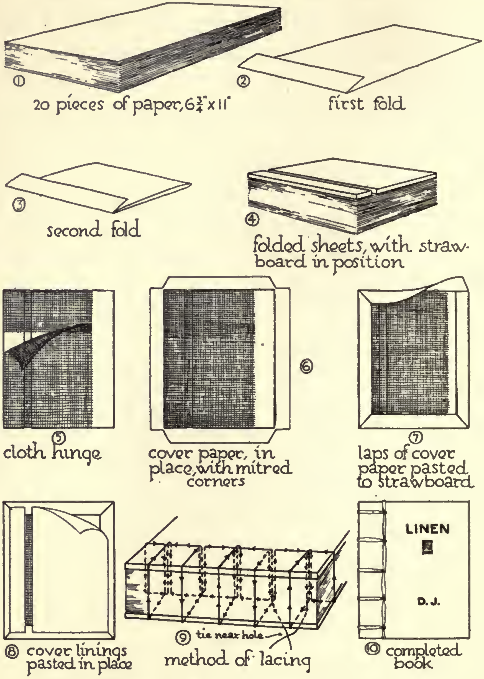
linoleum block (a block of soft wood about an inch in thickness to which a piece of linoleum, perhaps three sixteenths of an inch in thickness has been glued). Before transferring the design it may be necessary to reverse it by tracing the lines on the back of the sheet. This may be done by holding the paper against a window pane. The linoleum is cut away from those parts of the design which are not to print. A pad is made by

rolling up a strip of cheese cloth so that at least four thicknesses are piled one upon another. Over this pad is poured the ink, a mixture of liquid glue in which water color paints (tempera colors preferred) have been mixed. If the mixture is too stiff, add a few drops of water. There should be no superfluous ink piled up on the pad. If the ink does pile up on the block, it can be removed with a dry cloth. The block is applied to the pad several times before a print is made. It should be revolved slightly in the hand after each application to the pad in order to provide for an equal distribution of ink over the surface of the print block. By the use of the ink pad and linoleum block the design unit is printed upon the cover in just the place where it will appear to the best advantage. A *complementary* color scheme should be used, the color employed in the printed unit being the complement of that used in the marginal line and lettering, as, for example, yellow and purple-blue, red and blue-green, yellow-red (orange) and blue, etc.

II

The Making of a Japanese Book

Materials: two cover boards of strawboard, 3¾ inches by 6¾ inches; two pieces of strawboard for laced back, 1 inch by 6¾ inches; two pieces of cloth for cover hinges, 4 inches by 14 inches



The Making of a Japanese Book

(this will make two hinges 4 inches by 7 inches); two pieces of colored paper to cover strawboard covers, 6 inches by 7¾ inches; four pieces of paper for cover lining, two pieces 3½ inches by 6¼ inches, and two pieces ¾ inch by 6¼ inches; twenty pieces of paper for leaves, 6¾ inches by 11 inches.

(1) The twenty leaves are folded first. Place them in a pile on the table at one side, a short edge parallel with the front edge of the desk.

(2) Each of the sheets is now folded as follows: One of the short edges is folded over 1 inch and the paper creased. (This creasing is best accomplished by applying pressure first in the center of the fold and then carrying the pressure in both directions simultaneously with the index fingers of both hands. A pencil line is drawn 2 inches from the short edge of each sheet before creasing. By placing the edge even with this line, 1 inch of paper will be folded over.)

(3) Fold the opposite short edge over to the crease just made and place under the flap.

(4) Fold each of the nineteen pages remaining in like manner.

(5) Arrange the folded pages in a pile, each with the three thicknesses of paper on the same side. The covers are now assembled as follows:

(6) Place one of the small pieces of strawboard on the topmost folded sheet of paper. The folded sheet is 6¾ inches by 5 inches; the piece of strawboard, 1 inch by 6¾ inches. It is placed directly

over the flap. Make three edges of the strawboard lie along three edges of the folded sheet.

(7) Now place one of the large pieces of strawboard on the folded sheet beside the smaller piece. This strawboard is the piece 3¾ inches by 6¾ inches. Make three of its edges lie along the three remaining uncovered edges of the folded sheet. The two pieces of strawboard are now ¼ inch apart, since 5 inches (the width of the folded sheet) minus 3¾ inches (the width of the larger piece of strawboard) minus 1 inch (the width of the smaller piece of strawboard) equals ¼ inch.

(8) Glue or paste is applied to the two pieces of strawboard which are now placed with their long edges ¼ inch apart.

(9) The piece of cloth which is used as a hinge is now wrapped around the two pieces of strawboard. It is wrapped lengthwise and, being 14 inches long, it goes entirely around the cover which is but 6¾ inches long. It will overlap almost half an inch. (This is determined by the thickness of the strawboard.)

(10) The other cover is assembled in the same way.

(11) The boards are now covered with the colored paper which is allowed to project ½ inch on all four sides. The cover paper is pasted to the cover board, paste being applied to the entire surface of the strawboard. A piece of newspaper is used to protect the worker's table, and a clean piece is placed over the work for pressing.

(12) After the surface has been covered the cover paper is cut at a *miter*, as shown in the illustration, at each of the four corners.

(13) Paste is now applied to each lap and the laps pasted down.

(14) The covers are lined with the two pieces prepared, 3½ inches by 6¼ inches, and ¾ inch by 6¼ inches respectively. The lining paper is pasted upon the inside of the covers. A space is left between the two pieces of lining paper in each case that the hinge may act freely.

(15) The pages and covers are now arranged and punched for lacing. The covers should be punched first and the pages may be marked for punching using the front cover as a guide. There may be either an odd or an even number of punched holes.

(16) The book is now laced in the manner shown in the illustration. An ordinary shoe lace or a piece of colored cord will serve this purpose. The leaves are left uncut.

If a light brown cover paper is used a tan shoestring will be effective as a lace. This will provide for an attractive combination of differing values of a single hue, *monochromatic scheme*. If another color is used a white lace may be dyed to the appropriate hue and value.

The making of a decoration for the cover will furnish an opportunity for design. The design may be made with water colors or crayons or by

pasting upon the cover a cut silhouette and strips of paper to form the letters. There should be a lettered title. The subject of the book and its use should previously have been determined.

III

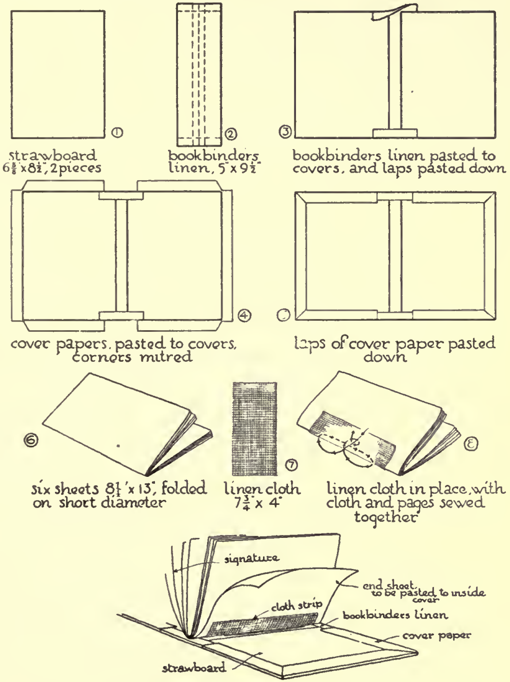
The Making of a Book of One Signature

The cover boards for this second book will be 1/8 inch wider and 1/4 inch longer than the page, in order that the covers may project beyond the pages. The size and proportions will be determined by the purpose for which it is to be made. Decide upon the use to which your book is to be put. The book described here is suitable for the mounting and preserving of reproductions of masterpieces in art. Each picture should be mounted on a page of odd number, while its story is written on the page at the left or on a page of even number. The mounting of the pictures, the arrangement of written material, and the observing of margins according to the best typography, are problems in design.

(1) Choose a rectangular piece of strawboard large enough to make one cover board.

(2) Place this on the desk so that it lies vertically in reference to the edge of the desk nearest you, which is horizontal.

(3) Place the ruler on the strawboard along the upper edge.



A Book of Single Signature

(4) Measure 6⅝ inches from the left corner and place a point.

(5) Place ruler on desk just below the lower edge of the strawboard and place a point on this edge 6⅝ inches from the left edge.

(6) Draw a line connecting this point with the one on the upper edge.

(7) Place ruler on left edge of strawboard and measure down on left edge 8½ inches from upper corner and place a point.

(8) Measure down on pencil line 8½ inches from upper edge and place a point.

(9) Connect this point with that on the left edge of the strawboard.

(10) Cut out cover board.

(11) Lay out and cut second cover board.

(12) To lay out linen back, measure off on back of bookbinder's linen, dimensions 5 inches by 9½ inches, just as you measured out the strawboard, first from the left edge and then from the upper edge.

(13) Draw a *center line* lengthwise of this material.

(14) Draw lines across either end parallel with the short edges of the material and ½ inch from them.

(15) Paste the linen back to the cover boards, leaving ⅜ inch between the boards (the thickness of the book will determine this measurement).

Caution: You should have at hand a pile of papers each about 9 inches by 12 inches. Torn newspapers will serve the purpose. These are to

protect your work as it is being put through the various processes of pasting. The papers should be stacked before you and you should keep your work upon the uppermost piece which is always clean, since you crumple the papers and drop them on the floor as soon as they become soiled with paste or glue. These papers must also be used under the hand when rubbing one pasted paper upon another. At the close of the period the crumpled papers are picked up and put into the waste paper basket.

(16) To prepare cover papers 5⅝ inches by 9½ inches, measure as suggested above. (See steps 2 to 9, inclusive.)

(17) Paste cover paper to cover boards, cutting corners on miter and then pasting down laps.

(18) Count out half as many papers as there are to be leaves in the book, in this case, six papers. There should be a supply of paper stock for this purpose cut 8½ inches by 13½ inches.

(19) Measure and cut this paper into pieces 8¼ inches by 13 inches.

(20) Fold each sheet to make two pages, 6½ by 8¼ inches.

(21) A piece of ordinary linen cloth is now prepared for holding the covers to the leaves of the book. It is measured and cut ½ inch shorter than the length of the papers (or 7¾ inches long and 4 inches wide).

(22) Draw a center line lengthwise of this material.

Letters and Figures Designed on Squared Paper

(23) Place pages together and *stab* or pierce for sewing. Stabbing may be accomplished by means of a fine awl or a coarse needle.

(24) Place the linen outside the folded pages, its center line lying along the stabbed holes, and sew the pages and linen together, the needle first entering the center stabbed hole, proceeding in and out to one end of the row of stabbed holes then back to the opposite end, and so on to the center, where the knot is tied. There should be an odd number of holes, either 3 or 5.

(25) Fasten the signature or section of pages to the cover boards by pasting the linen to the cover boards, being careful to center the signature at the back, in reference to the cover boards.

(26) Paste down the end sheets (the leaves next to the covers).

IV

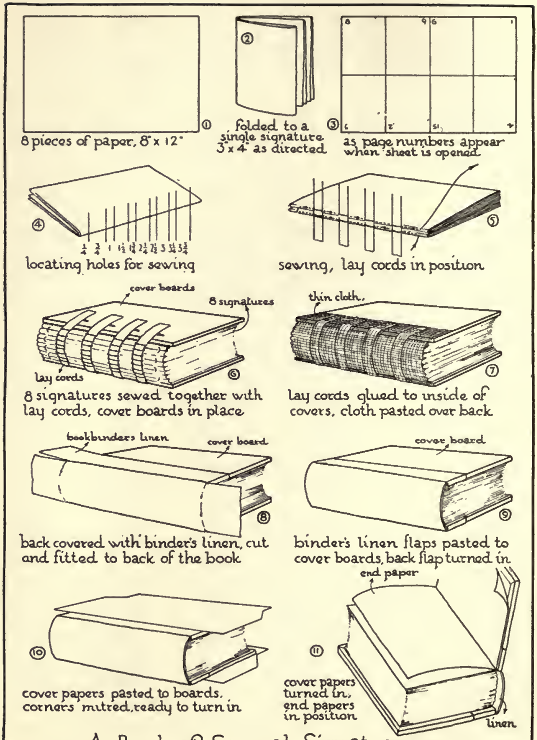
The Making of a Book of Several Signatures

The following are the steps in the making of a book of eight signatures:

(1) Cut eight pieces of paper, 8 inches by 12 inches, for the leaves.

(2) Place the sheets in a stack on the desk with their longer sides along the edge of the desk nearest you.

(3) Fold the back edge of the uppermost sheet over toward you, to the edge of the desk, and crease.



A Book of Several Signatures

(4) Fold the right edge of this folded sheet over toward the left, to within 1/16 inch of the left edge, and crease. (The 1/16 inch is allowed for the next folding, as will be seen after the next operation.)

(5) Fold the sheet again, as before, this time bringing the right edge entirely over to the left edge. All edges at the left should now be even. The folded signature should measure 3 inches by 4 inches. Turn the signature so that its folded edge is at the left and the open edge toward you.

(6) Number the pages in this first signature, placing numbers on both sides of each leaf, as in an ordinary book. Open out the sheet and note the arrangement of the pages as numbered. Were this to be a printed book, the numbers would guide the printer in arranging his pages of typed matter. Fold the signature together again.

(7) Fold the seven remaining sheets in the same way, thus forming seven additional signatures.

(8) Take the first signature and place your ruler so that it lies along the folded edge, which will later be at the back of the book. Measure from one end of the signature, along this folded edge, the following distances (without moving your ruler from its original position) and place points: 1/4 inch, 3/4 inch, 1 inch, 1 1/2 inches, 1 3/4 inches, 2 1/4 inches, 2 1/2 inches, 3 inches, 3 1/4 inches, 3 3/4 inches. These are the points through which the needle will pass in sewing the signatures to the *lay cords*, cords which in turn will be laced into

the covers, thus fastening them securely to the book.

(9) Place the signatures in a stack, as they will be arranged in the book, placing the first signature on top. Number the signatures, using small Roman numerals. Number the pages consecutively, continuing to the end of the book. What will be the figure on the last page numbered?

(10) Mark the folded edge of each of the signatures in turn for sewing, using the first signature as a pattern.

(11) Stab holes for sewing. This may be done with a large needle, an awl, or a hammer and nail.

(12) Provide four lay cords, each 7 inches long. Shoe laces are excellent for the purpose, though any strong cord will do.

(13) Start sewing the first signature to the lay cords. The progress of the needle will be as follows: Into first signature through the hole nearest one end of signature; to next hole; through this hole to outside of signature; around first lay cord to next hole; through hole into signature; on to next hole; through this hole to outside of signature; around second lay cord and into signature; etc., until the last hole has been reached.

(14) Place second signature in position for sewing. The progress of the needle will be as before, except that the direction will be reversed. When the needle has reached the hole above the first hole entered in the first signature a knot is

tied to strengthen the union of the first two signatures, the loose end projecting from the first signature being tied to the thread extending through the corresponding stabbed hole in the second signature. The sewing is continued to the third signature, the direction of sewing again being reversed. When the last signature has been sewed to the lay cords, a final knot is tied to strengthen the union of the last two signatures. Place glue between the signatures near their back edges. A mucilage brush or splint of wood (a toothpick) should be used for this.

(15) Round the back of the book by pressing the front edges of the signatures with the thumbs, and place it in a vise or under a heavy weight.

(16) When the glue has set, spread more glue over the back of the book, being careful not to get any of it on the parts of the lay cords that are to act as hinges for the covers. (Lay cords with glue on them will break off when the covers are opened.) Leave your book under pressure until all the glue has set. (Paste may be substituted for glue if desired.)

(17) Cut two cover boards 3⅛ inches by 4¼ inches from strawboard or heavy pasteboard.

(18) Place covers in position, allowing them to project ⅛ inch beyond the front, top, and bottom edges of the book. The space thus provided between the back of the book and the cover boards will be allowed for the working of the hinges.

(19) Mark points on cover boards to indicate the positions of the lay cords, placing these points ½ inch in from the long edge of each cover board and opposite the lay cords.

(20) Punch the cover boards to admit the lay cords at these points. The cords will enter from the outside of the book and will be glued to the inside of the cover boards.

(21) Cut a piece of thin cloth 3 inches by 5 inches for the hinge. Fold ½ inch of this material in at each end and paste down upon itself.

(22) Paste this cloth down, centering it on the back of the book.

(23) Place the book between the covers, thread the lay cords through from the outside, and glue their ends to the inside of the cover boards; also paste the cloth hinge to the outside of the cover boards. (Remember to avoid getting any paste or glue on the parts of cloth which are to act as hinges.)

(24) Cover the back of the book with bookbinder's linen, pasting it to the cover boards, but NOT to the back of the book. This material must be cut and fitted to the back of the book. Try thin paper and work out a pattern before using your bookbinder's linen. When you have made a satisfactory pattern transfer it to the linen.

(25) Cover the boards with cover paper as you did in making the book of one signature. (See page 35.)

(26) Prepare a piece of paper for the end sheets

6 inches by 8 inches, and cut it into two sheets 4 inches by 6 inches. Each of these is folded to form two end sheets 3 inches by 4 inches, which may be decorated by an all over surface pattern design printed with a wood block, if desired.

(27) Paste in the end sheets so that the covers may be opened and closed without difficulty.

(28) Put the book in press, or beneath weights.

V

The Making of a Portfolio for Drawings or Written Work

(1) Cut strawboard 9 inches by 11 inches for covers.

(2) Cut a piece of cloth for fastening covers together, 4½ inches by 13 inches.

(3) Place cover boards on desk, 1 inch apart.

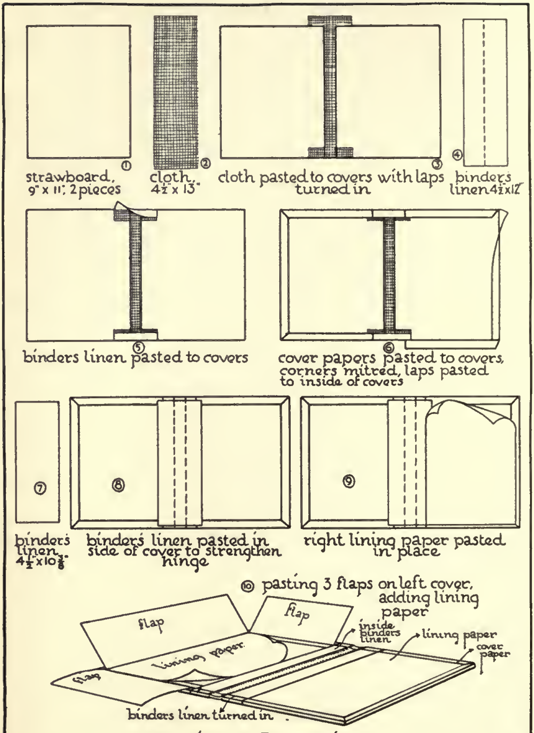
(4) Cover the cloth with paste; then paste it on the cover boards, allowing 1 inch of cloth to extend at each end of cover boards.

(5) Turn the 1 inch of cloth extending at each end of the cover boards back over the cover boards and paste down.

(6) Cut bookbinder's linen, for covering the back of the portfolio, 4½ inches by 12 inches.

(7) Draw a line through the center of this linen, lengthwise, and place this line over a center line drawn lengthwise on the piece of cloth; cover with paste and paste to the cover boards.

(8) Turn down ½ inch of linen extending at



Making a Portfolio

each end on the inside of the cover boards, and paste down.

(9) Cut cover papers 8½ inches by 12 inches.

(10) Paste cover papers on cover boards. (Place them 2 inches from the center of the cloth back, and paste.) Miter the corners.

(11) Cut another piece of bookbinder's linen, 4½ inches by 10⅝ inches.

(12) Place this on the inside of the covers so that it will be ⅜ inch from each end of the cover boards. Center it on the cloth; paste securely to the cloth to make the hinge stronger.

(13) Cut the inside lining papers, 7 inches by 10⅝ inches.

(14) Place one lining paper on the cover board, so it will be ⅜ inch from front, top, and bottom of portfolio, and paste down.

(15) Cut three pieces of paper for flaps in portfolio, two pieces 6⅞ inches by 4¼ inches, one piece 10⅝ inches by 4¼ inches.

(16) Turn or fold down ½ inch on a long edge of each piece of paper.

(17) Paste these folded edges to the cover board still unlined, ⅜ inch from each of its edges, using the shorter pieces for the shorter edges.

(18) Place the other lining paper over the inside of these flaps and over the remaining surface. This will make the pocket of the portfolio.

(19) Lay portfolio flat in press and leave it until dry.

(20) A design should be worked out for the portfolio, suggestive of its use.

VI

Posters

Posters offer excellent opportunities for combining industry and art. The motive for making one might well be the advertising of a school game or entertainment. In the making of a class poster all members of the class are provided with linoleum blocks just alike. An entire alphabet is cut, each pupil cutting a letter. Each member of the class now sketches a small poster design. The most satisfactory design is chosen for the large class poster. The large poster is printed, each pupil in turn inking and impressing a letter. The pupils should form in line, each with type block in hand, to spell out the words needed.

In applying the print block to the paper, pressure must be exerted upon each of the four edges of the block in turn. Only by taking this precaution is the printing of a clear image assured. If a press or an improvised press is used this would, of course, be unnecessary. Two pupils should be chosen to act as foremen. It must be kept in mind that the letters forming the words must be placed close together and that the spaces between the words should appear equal. The printed lines can be kept straight by means of thumb tacks and strings. The principle of *balance*

should be observed in the arrangement of printed matter upon the page. A pad of soft papers, placed underneath the poster paper, will facilitate the printing.

The Monastic Scribe

To those dim alcoves, far withdrawn,
He turned with measured steps and slow,
Trimming his lantern as he went;
And there, among the shadows, bent
Above one ponderous folio,
With whose miraculous text were blent
Seraphic faces: Angels, crowned
With rings of melting amethyst;
Mute, patient Martyrs, cruelly bound
To blazing fagots; here and there,
Some bold, serene Evangelist,
Or Mary in her sunny hair;
And here and there from out the words
A brilliant tropic bird took flight;
And through the margins many a vine
Went wandering—roses, red and white,
Tulip, wind-flower, and columbine
Blossomed. To his believing mind
These things were real, and the wind,
Blown through the mullioned window, took
Scent from the lilies in the book.

Thomas Bailey Aldrich

From "Friar Jerome's Beautiful Book." Houghton Mifflin Company.

Exercises for Study and Review

(1) Compare the methods of bookmaking that obtained during the middle ages with those of to-day.

(2) Visit a small job printing establishment if possible. If you have a print shop in the school building you should visit it as well. Write an account of your visit and make at least three drawings to be used as illustrations.

(3) How are we who live to-day affected by books and other publications?

(4) Imagine the world without any printing for the period of one year, beginning to-day. What do you think would be the result?

(5) How is type set for printing?

(6) Who was John Gutenberg and what did he contribute to the art of printing?

(7) See if you can find out how many signatures were used in the book which you are now reading. How many do you find? How can you tell?

(8) Give a brief interpretation of "The Engraver" by Mathey. (See page 15.)

(9) Benjamin Franklin, who wrote the poem quoted at the close of the next chapter, was a printer by trade. See what you can find out about Franklin as a printer. Look in the encyclopedia or elsewhere.

(10) Which illustrations in this chapter are halftone reproductions and which are line cuts?

(11) To what extent does a printer have to be an artist? Do you think you would be successful at the printer's trade? Why?

(12) Make a careful copy on squared paper, of the alphabet given on page 36.

SUGGESTED READING ABOUT THE MAKING OF BOOKS

Aldrich.—*Friar Jerome's Beautiful Book* (a poem of the monastic scribe). Houghton Mifflin Company.

Bush and Bush.—*Industrial and Applied Art Books*, V, VI, VII, VIII. Atkinson, Mentzer & Co.

Buxton and Curran.—*Paper and Cardboard Construction.* The Menomonie Press.

Cockerell.—*Bookbinding and the Care of Books.* D. Appleton & Co.

Davenport.—*The Book, Its History and Development.* Archibald Constable & Co.

Dobbs.—*Illustrative Handwork* (Pages 52–57). The Macmillan Company.

Earle.—*Child Life in Colonial Days* (Chapters V and VI). The Macmillan Company.

Forman.—*Stories of Useful Inventions* (Chapter XV). The Century Company.

Holland.—*Historic Inventions* (See *Gutenberg and the Printing Press*). George Jacobs & Co.

Rawlings.—*The Story of Books.* D. Appleton & Co.

Rodgers and Others.—*Trade Foundations* (See index under *Bookbinding, Pressman*). G. M. Jones, Indianapolis.

Rocheleau.—*Great American Industries* (Pages 156, 184, 208). A. Flanagan Company.

Snow and Froehlich.—*Industrial Art Text Books,* V, VI, VII, VIII. The Prang Company.

Stillwell.—*The School Print Shop.* Rand McNally & Co.

Wells.—*How the Present Came from the Past,* Book Two (Index under *Alphabet, Books, Brick Stamp, Cameo, Molds, Picture Writing, Records, Scribe*). The Macmillan Company.

Typical Paper Mill

II

PAPERMAKING

It is not possible for us to obtain the earliest history of the race, for its activities in those remote times were not recorded as they would be to-day. History was at first repeated from father to son by word of mouth, and thus *traditions* were handed down from generation to generation.

Later, people began to see that sometimes traditions were forgotten or the stories retold in different ways. It was evident that a method was needed for recording events accurately and for all time. To meet this need, stone *covenants* or *cairns*—great heaps of stone—were set up. Later still, *obelisks* with inscriptions on them were employed. There is in Central Park in New York City an obelisk which was brought to New York from Egypt.

Events of minor importance were of course left unrecorded because it was too expensive to set up cairns or obelisks to commemorate these. The people of Chaldea and Assyria overcame this difficulty by inscribing their records on soft *clay tablets* which were sometimes baked in a fire. Many of these tablets are still preserved. Tablets of bone, brass, lead, and gold were also used for inscriptions. Later still, *wooden boards with a thin coat of wax* were posted in public places in the towns of the Roman Empire. Each day the news items were scratched on these boards. When men wished to erase the inscriptions they simply heated the wax and allowed it to cool again into a hard, smooth slab. These news boards were the forerunners of our modern newspaper.

Messages often had to be sent long distances and the tablets and boards were too heavy to transport. Thus writings came to be inscribed on the dried skins of animals. It was discovered also that layers of the *papyrus* reed could be made into a satisfactory writing material. This plant grew along the Nile River in Egypt. Layers of papyrus were laid across one another and, after being moistened with water and pounded, were compressed to a thin sheet and polished with a smooth piece of ivory. Since papyrus grew only along the banks of the Nile, the King of Egypt at that time had entire control of the supply of the world's best writing material.

When the King of Pergamos in Asia wished to create a great library, the King of Egypt refused to furnish him with the papyrus needed. The King of Pergamos then discovered a method of making *parchment* from the skins of sheep, goats, and calves. Thus, his library grew rapidly. The skins were first steeped in lime to remove the oil, hair, and foreign matter. Next they were stretched tight upon frames, and scraped to a uniform thickness by means of sharp knives. They were then sprinkled with chalk and polished with pumice stone. Although parchment proved to be an excellent material for writing, it was entirely too expensive for any but the rich. A cheaper material was needed.

Egyptian Papyrus

As early as 600 A.D., the Chinese had made a material upon which writing could be inscribed, by forming into a sheet the fibers of the wood of the mulberry tree. About 751 A.D., the Arabians also learned the secret and made paper from other vegetable fibers. This knowledge in turn was acquired by the Moors, and with the capture of Samarkand by the Spaniards it was introduced into Spain, and eventually throughout the entire continent of Europe. Papermaking soon flourished

in Holland, Germany, and England. With the immigration of Hollanders to America, the first American paper mill was established at German-

Mary R. Cornwell *H. Reeve Angel & Co., Inc.*

The Paper Maker

town, Pennsylvania. Paper was then made only by hand and from rag pulp.

Some of the raw materials used in the making of paper to-day are linen (flax), cotton rags, wood, esparto grass, straw, hemp, jute, bamboo, silk, and sugar cane refuse. These materials, according to their different fiber formation, are *ground* to

pulp as are the soft woods, or *cooked* as are straw and some of the hard woods. After this preliminary process they are *bleached*, except when this is not desired, and are made into paper.

Butler Paper Corporations

Sorting Rags

Paper is of three general varieties,—writing paper, paper for printing, and wrapping paper. Among the special kinds are vulcanized, corrugated (straw), carpet, waxed, crêpe, blue-print, papier-mâché, asbestos, tar, cardboard, stencil, transparent, tissue, and filter. Paper has not only filled the demand for a cheap, serviceable writing material on which the history and development of the race is being recorded, but it is also useful in many other

ways. Layers of wood-pulp paper subjected to an enormous pressure produce a very hard substance which is even used sometimes to cover the rims or tires of car wheels.

The manufacturer of paper is dependent upon the vast natural forest resources of the country

U. S. Forest Service

Logs in Pond near Pulp and Paper Mill, Lincoln, New Hampshire

for a supply of wood, and upon the rag picker for a supply of rags. The logs from which paper is to be made, after entering one end of the mill, go through the several processes of grinding and cooking which finally reduce them to pulp. The beating of this pulp and the running of it into the paper machine which transforms it into paper is most interesting. The rags are sorted according to their different qualities, before they go through

the boiling and bleaching processes. The white pulp, afterwards, is either mixed with wood pulp or used alone, and is run through the *beating engines* from which it comes as a snow-white sheet.

We should all assist in the conservation of paper by helping to perpetuate our trees and forests and by saving all our old rags and waste paper. If these materials are thrown away or destroyed, we shall have to pay higher prices for the paper which we buy, for paper materials are becoming more scarce all the time.

Rags to be used in the manufacture of paper are gathered and sent in bales to the paper mill, where the rags are fed into a machine called a *thrasher*, which beats them and removes most of the dirt. This is carried off by means of tubes. The rags are then sorted and all buttons, hooks, eyes, and other hard substances removed.

The largest rags are now cut by hand into smaller pieces and are put through a *cutting machine*, which chops them into smaller bits. These are fed into another machine called a *whipper*. The whipper contains two cylinders, one operating inside the other. Spikes project from the outside of the inner cylinder and from the inside of the outer one. As the two cylinders are turned in opposite directions, the rags passing between the spikes are literally torn into shreds, while tubes again carry off the dust.

The real process of cleaning begins when the

huge lids of the *rotary boiler* are opened to receive the torn rags into their solution of *lime* or *caustic soda*. The whole mass is cooked for about twelve hours by means of steam, after which the rags, in the form of pulp, are dumped on the floor from the boiler, and the lime or soda solution, which contains a great deal of dirt, is allowed to drain off.

The pulp is now put into *washers* similar to those used in laundries, and the remaining dirt and lime or soda solution are washed out. The pulp is then rinsed in clean water and bleaching material until the pulp finally comes from the washers bleached white.

The pulp is then dumped into concrete vaults with perforated floors called *drainers*, and is allowed to drain slowly. Sometimes several weeks are required for this process. Next it is subjected to *beaters*, which further break and tear it and separate the fibers. Other substances, such as wood fibers, are sometimes added during the process of beating to produce a stronger paper. *Rosin* is worked in to hold the fibers together, and coloring materials if the paper is to be colored, both of which are held to the fibers by adding *alum*.

The pulp, containing the materials added during the beating process, is now run into *storage chests* containing water. These chests are furnished with *agitators*, or paddles similar to those of a churn, which constantly stir the liquid and mix it thoroughly. The water containing the pulp in even

suspension is run over shallow boxes, the bottoms of which are covered with felt, and upon these felt bottoms is deposited the dirt which was too heavy to be carried out in the earlier processes.

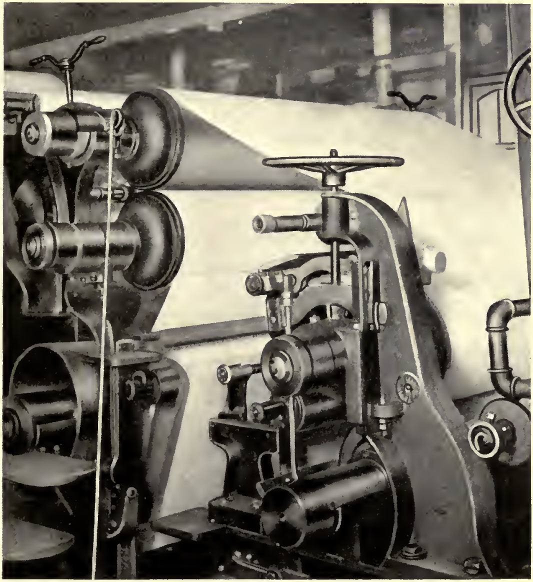
Butler Paper Corporations

Beater

The liquid pulp is now forced through a screen which further refines it and straightens out the fibers. It is then conducted to an endless belt of wire cloth which carries the pulp along. As it moves, the water passes through the belt, but the fibers are carried on. Under the belt a trough carries off all the surplus liquid and conducts it back into the storage chests.

The pulp on the belt is carried between rolls

which wring it just as clothes are wrung in a wringer; these are called the *press rolls*. A separate



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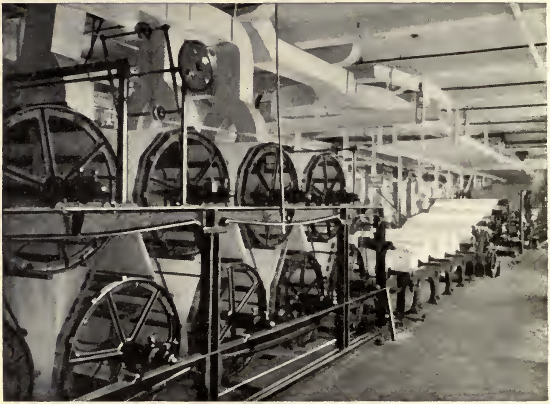
Pulp Being Carried to First Set of Press Rolls

wire roll over the wire cloth belt, called a *dandy roll*, sometimes impresses into the pulp sheet the *watermark*, which is generally the trade mark of the manufacturer by whom the paper is to be used.

From these rolls the pulp, which we may now call *paper*, passes between still other rolls which, heated by steam, dry up the water. After this the dry paper passes through highly polished rolls, called *calenders*. These compress it, and give



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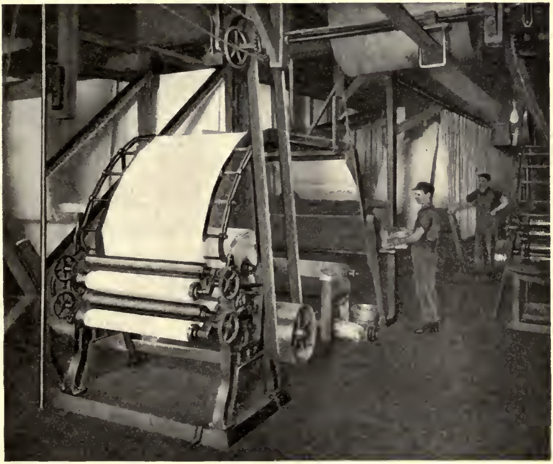
Paper Machine, Showing Front End of Cylinder Drier

it a smooth finished surface. The amount of finish is generally determined by the surface of these last mentioned calender rolls; that is, if an exceptionally high finish is desired, a highly polished roll must be used. The paper passes through a great number of rolls in turn, until the proper thickness, smoothness, and gloss are obtained.

Two methods are used in manufacturing paper

from wood pulp. If the pulp is to be used for *newsprint* only, the wood is merely pressed against a stone similar to a grindstone, and ground away into fine pulp. If the pulp is to be used for writing paper, or for wrapping paper, it is boiled with acid or alkalies, in a cylindric tank called a *digester*, and in this way is reduced to a pulp.



Butler Paper Corporations

Festoon Drier
Paper Hanging in Festoons at the Right

The poorest grades of paper are made of wood or by combining wood fiber with old rags and papers; the finest grades are made from new rags direct from the cloth mills.

If the paper is to be ruled as we find it in our school tablets and composition books, it is first cut into large sheets when it comes from the rolls in the paper mills. Then the tablet maker cuts it into sheets of the proper size. He rules it on a *ruling machine* by passing the large sheets under stationary pens which are automatically fed with ink of the required colors.

How to Make Paper

Bring clean scraps of white cloth (linen preferred) to school.

(1) Tear the rags into little bits about ½ inch square or smaller. Pull threads apart. A *file card* or other card made by driving brads through a piece of thick pasteboard will make this an easy matter. A brush with wire teeth will also answer the purpose.

(2) Four or five sticks of caustic soda should be dissolved in six quarts of water.

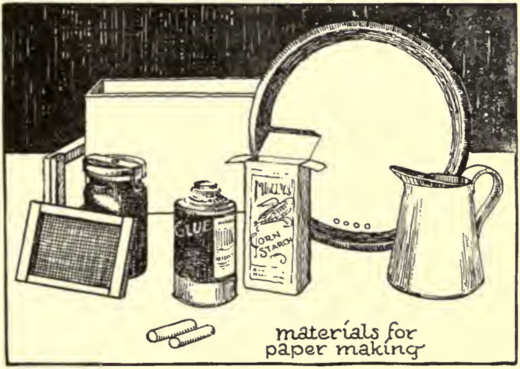
Caution: Caustic soda, or sodium hydroxide, comes in stick form and is poisonous. It should be provided and cared for by the teacher.

(3) The fine bits of cloth are now stirred into this. Perhaps nine quarts of shredded linen packed tight will be enough to make forty sheets of paper 4½ inches by 7 inches.

(4) The caustic soda solution containing the rags in suspension is boiled for from six to eight hours. This may be done out of doors if there is no stove in the school building.

(5) Rinse the rags thoroughly in three waters. Pour the mixture into a colander and wring the rags each time. A soap solution, milky-white, will be useful in this washing process.

(6) Run the rags through a food chopper or clip very fine with scissors, reducing them to a fine pulp.



materials for paper making

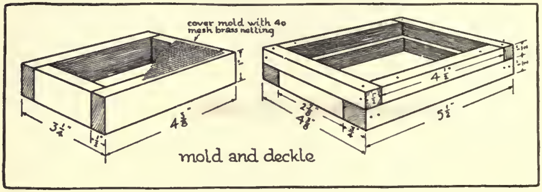
(7) If it is desired that the paper should be tinted, the pulp should be passed through water containing dye. It should be washed after dyeing.

(8) Put pulp into a wash of six quarts of water containing eight tablespoonfuls of starch, four of liquid glue, and one of bluing.

(9) Agitate the wash by stirring with a paddle or stick and while the pulp is held in even suspension dip the *mold*, a screen the size of the proposed

sheet of paper, into the liquid. (A mold may be made by stretching a piece of ordinary wire fly screen over a small wooden frame.) When the mold is lifted out, the liquid is allowed to drain back into the tank.

(10) Place the *deckle*—a separate, thin, wooden frame—over the mold to form the *deckle edge.* (See illustration.)



(11) Turn the thin layer of pulp which has been deposited on the screen into a shallow dish. (A pie tin, in the bottom of which a few holes have been pierced with a nail and hammer, will answer this purpose.) A piece of cheesecloth should first be placed in the dish in order to prevent the pulp from sticking fast.

(12) Cover this first layer of pulp with a small piece of cheesecloth.

(13) Deposit a second layer of pulp on the cheesecloth; cover it with cheesecloth. Repeat this until the desired number of sheets has been provided.

(14) Apply pressure to the pile by placing it

in a letter press, by means of clamps or hand screws, or by weights, such as flatirons or heavy stones. The liquid will run out through the pierced holes as the pressure is applied. It is caught in a pail as it is squeezed out. The sheets of paper are now removed, each on its own piece of cheesecloth. They are still damp.

(15) Make a *size*, using one dessert spoonful of ordinary gelatine dissolved in a cup of boiling water.

(16) Place one of the sheets on the screen. Take a piece of cloth somewhat larger than the screen and place it over the sheet of pulp. Invert the screen on the table and lift it from the pulp. Cover the pulp over with a second piece of cloth. We now have the pulp sheet sandwiched between the two pieces of cloth.

(17) Keeping this flat, pass it through a clothes wringer. This process may be dispensed with if time has been allowed for the more gradual drying out of the pulp sheet. (If a wringer is used, steps 11, 12 and 13 may be omitted.)

(18) Put back each sheet of paper on the mold for sizing. This may be done with a bristle brush. (See Step 15.)

(19) Each sheet in turn is now placed between two pieces of cloth and is ironed with a hot flatiron until it is quite firm and dry.

(20) If a smooth finish is desired, the paper may now be removed from between the pieces of cloth

and ironed dry. Rub the bottom of the flatiron occasionally on a piece of fine sandpaper or emery cloth to keep it clean while in use.

Paper

Some wit of old—such wits of old there were—
Whose hints showed meaning, whose allusions care,
By one brave stroke to mark all human kind,
Called clear blank paper every infant's mind,
Where still, as opening sense her dictates wrote,
Fair Virtue put a seal or Vice a blot.

The thought was happy, pertinent, and true;
Methinks a genius might the plan pursue,

. . . .

Various the papers various wants produce—
The wants of fashion, elegance, and use;
Men are as various; and, if right I scan,
Each sort of paper represents some man.

Pray, note the fop—half powder and half lace—
Nice, as a bandbox were his dwelling-place;
He's the *gilt paper*, which apart you store,
And lock from vulgar hands in the escritoire.*

. . . .

The wretch whom Avarice bids to pinch and spare,
Starve, cheat, and pilfer, to enrich an heir,
Is coarse *brown paper;* such as peddlers choose
To wrap up wares, which better men will use.

. . . .

* A writing table used in colonial times.

Observe the maiden, innocently sweet;
She's fair *white paper*, an unsullied sheet,
On which the happy man whom Fate ordains
May write his name, and take her for his pains.

From "Paper," by BENJAMIN FRANKLIN

EXERCISES FOR STUDY AND REVIEW

(1) Why was paper invented?

(2) For what purposes is parchment used to-day?

(3) What kind of paper do you prefer for writing with ink, for drawing with pencil, for painting with water color?

(4) How can we all help to reduce the cost of paper?

(5) What is your opinion of the quality of paper used in this book? Of what do you think it was made?

(6) What is meant by the watermark in a sheet of paper? See how many watermarks you can collect. These can be mounted on a large sheet of thick pasteboard into which rectangular holes are cut to frame in each watermarked sheet of paper. The mounted samples of paper should be hung in the window where the light will shine through the paper and show the watermarks.

(7) How is paper made by hand?

(8) Tell the story of "The Papermaker," by Mary R. Cornwell.

(9) How is paper made by machinery?

(10) Where are some of the largest American paper mills located? Which of these mills use wood pulp and which use rag pulp as the foundation for their product?

(11) Make a diagram to show how paper is made in the factory, indicating all important machines.

Suggested Reading about Paper

Bishop and Keller.—*Industry and Trade* (Index under *Paper, Papermaking, Papyrus Plant*). Ginn & Co.

Bush and Bush.—*Industrial and Applied Art Books*, V, VI, VII, VIII. Atkinson, Mentzer & Company.

Butler.—*The Story of Papermaking.* J. W. Butler Paper Co., Chicago.

Buxton and Curran.—*Paper and Cardboard Construction.* Manual Arts Press.

Earle.—*Child Life in Colonial Days* (Page 79, *Scarcity of Paper*). The Macmillan Company.

Rocheleau.—*Great American Industries* (Page 138). A. Flanagan Company.

Rodgers and Others.—*Trade Foundations* (Index under *Paper*). G. M. Jones, Indianapolis.

Sindall.—*Manufacture of Paper.* Archibald Constable & Co.

Snow and Froehlich.—*Industrial Art Text Books*, V, VI, VII, VIII. The Prang Company.

Tarr and McMurry.—*New Geographies*, Second Book (Index under *Bamboo, Dyewoods, Fiber Products, Pulp Mills*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials* (Index under *Paper*). Ginn & Co.

Wells.—*How the Present Came from the Past*, Book II (Index under *Papyrus, Paper*). The Macmillan Company.

Williams.—*How It Is Made* (Chapter II, *Papermaking*). Thomas Nelson and Sons.

Baskets Made by School Children

III

THE MANUFACTURE OF BASKETS AND BOXES

Most manufacturers and dealers place their products upon the market in baskets, boxes, or *cartons*, for the consumer of the products realizes that they reach him in good condition only when properly packed.

Food products must be so packed that freshness for a long time will be assured. A certain biscuit company packs all its products for the retail trade in patented sealed packages which exclude moisture and dust. The package is lined with paraffined paper and covered with an ordinary grade of paper upon which the name of the product is printed.

Cartons are made of different kinds of paper according to the special use to which they are to be put. For example, those used for the packing of silverware are sometimes made from grass-bleached paper, which contains no chemicals that will tarnish the silver.

It will probably be a matter of but a few years before wooden boxes, except for very heavy packing, will be relics of the past. They are rapidly being

replaced by *corrugated containers*. Straw is used in the making of these containers, whereas rags and wood pulp are employed in the manufacture of all the finer grades of paper boxes. Corrugated containers, as substitutes for wooden boxes, are light and strong and they withstand water fairly well. The air spaces provided in the walls keep out heat and cold. The arched construction of corrugated paper gives strength and elasticity with comparatively small weight, and the cost is less than that of dressed wooden boards.

Baskets and berry crates are generally made from thin strips of basswood. The logs from which they are made are sawed to the proper lengths and, after being boiled for about five hours and stripped of their bark, are put on a *turning spindle* and revolved against a knife which cuts off thin strips of the wood. These strips are cut by machine to the proper lengths and widths for basket splints. After the splints have been woven and fastened, the basket is pressed into the proper form and dried. Serviceable baskets and crates are made in this way at a very low cost.

Some kinds of woven baskets are made from willow twigs and others from rattan. Rattan is a climbing vine which is abundant in the Philippine Islands. These vines often grow to be over a hundred feet in length. In the factories the long rattan canes are placed in a trough of water and soaked. Each strand in turn is drawn through a series of

small knives that strip off the outer bark in *ribbons* which are used for caning the seats of chairs. The strands are then drawn through a second set of knives which cut out flat strips of *reed winding* usually one quarter of an inch wide. The *round reed* of commerce is obtained from the center of the rattan strand. Round reed is graded in sizes by numbers ranging from 00 (very fine) to 9 (heavy). The largest strands are cut lengthwise into thin slices called *flats* which are used in weaving rectangular baskets.

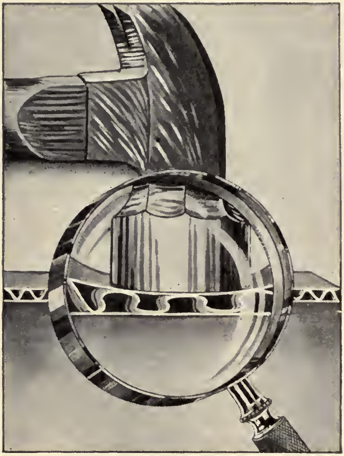
Books are often packed in corrugated paper.

The Making of a Woven Basket

Let us make a design for a small basket to be made of rattan. We shall make a silhouette or outline pattern by folding and cutting a piece of paper. This outline is transferred to a sheet of drawing paper.

In the weaving of rattan baskets the reeds which form the skeleton framework are called *spokes*, while those which pass in and out, thus filling in between the spokes, are called the *weavers*.

Rattan should always be moistened before it is used, but it should never be put into hot water and should not be soaked for more than half an hour. The reeds to be used as spokes should be cut to the proper lengths and tied together in bundles before wetting; those to be used as weavers should be coiled and tied before being wet. The worker should keep his fingers moist by dipping them occasionally into water.



Corrugated paper will withstand a heavy blow.

In making a rattan basket from five to eight inches in diameter, it is advisable to use No. 4 rattan for the spokes and No. 2 rattan for the weavers. The basket maker takes four spokes in each hand, and, pressing these flat so that they lie beside one another, he places the four spokes held in the right hand upon the four held in the left hand. The groups of four reeds each are now made to cross each other at right

Margaret Shepard

THE BASKET MAKER

angles, the point of intersection being midway from end to end on each group of reeds. A half-length spoke is now placed beside one group of four and the weaving is begun, the weaver proceeding over and under each of the four groups of spokes in turn, until all the spokes are held securely in place. The spokes are now separated, and the weaver is passed over and under each spoke in turn.

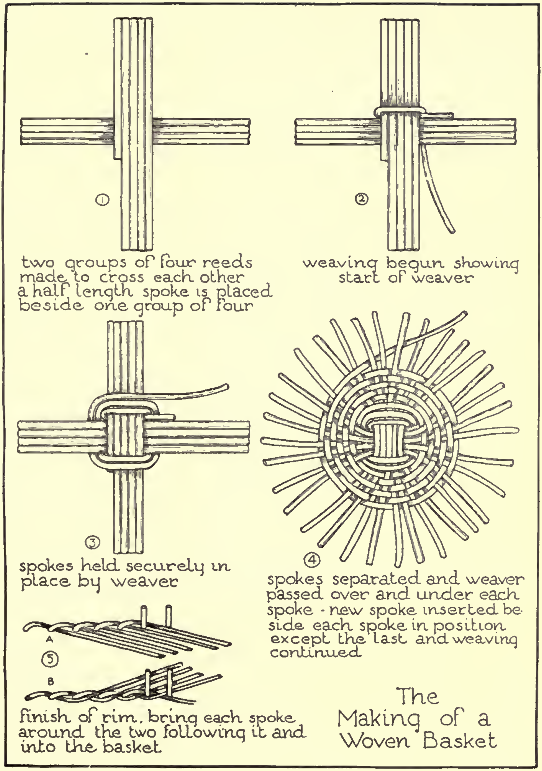
When the *start* has reached a diameter of five or six inches a new spoke is inserted beside each of those already in position except the last. This makes thirty-three spokes in all. The weaving of the basket is carried on to completion. If the sides of the basket are to turn up abruptly the spokes will have to be bent. They may be tied together at their ends to keep them bent until the turn is made. To finish the rim, bring each spoke around the two following it and into the basket, moistening the reeds, pulling them into place, and pressing them tightly down upon the basket.

Teacher's Note: A large diagram placed upon the blackboard to illustrate the method of starting the basket will be found helpful in teaching the operations of construction. The instructor may also start a basket before the class.

I

The Making of a Basket over a Form

By means of forms, baskets may be made in a much shorter time than by the old method.


①
two groups of four reeds made to cross each other a half length spoke is placed beside one group of four
②
weaving begun showing start of weaver
③
spokes held securely in place by weaver
④
spokes separated and weaver passed over and under each spoke - new spoke inserted beside each spoke in position except the last and weaving continued
A
⑤
B
finish of rim, bring each spoke around the two following it and into the basket
The Making of a Woven Basket

Forms are often used by the craftsman basket maker. They make the work of weaving easier and they enable the craftsman to produce baskets which are symmetrical.

The forms are made by using two circular discs of 7/8 inch white pine stock. The disc used at the top of the form is 10 inches in diameter, with a circular opening 6 inches in diameter through which the arm of the worker may be inserted. The diameter of the disc at the bottom of the form is 9 inches, 1 inch smaller than that of the one at the top, so that the form may taper to allow clearance for removing the finished basket. A 5/16 inch hole is bored through the center of the smaller disc to admit a 1/4 inch bolt which is used in connection with a wooden block, through the center of which has been bored a hole of the same size, to hold the spokes tightly against the bottom of the form while the weaving goes on. Two of these forms are shown in the illustration at the beginning of this chapter. The slats used to connect the two discs are made from 3/8 inch white pine, 1 1/2 inches wide and 14 inches long. The slats are nailed at their ends to the edges of the discs. The brads used are *set* 1/8 inch below the surface of the slat and the entire form is then *planed* to roundness.

As soon as the spokes are cut to length, which in the case illustrated is 3 feet, 9 inches, the basket bottom is started in the hands by the customary

method of crossing the spokes. The weaving now progresses rapidly.

As soon as the start for the bottom of the basket has reached a diameter of about six inches, it is fastened to the form, the bolt being inserted first through the wooden block then through the center of the start and on through the center of the disc. The nut is screwed on the bolt from the inside, the arm of the worker being inserted through the opening in the large disc. Just before the long spokes are turned up to form the sides of the basket, an additional spoke is inserted beside each of those already in place. No. 7 reed is used for the spokes, No. 4 for the weavers. Beautiful baskets may also be made from willow and hemp rope, the willow furnishing the spokes.

A table built on a saw horse holds the form over which this boy is weaving.

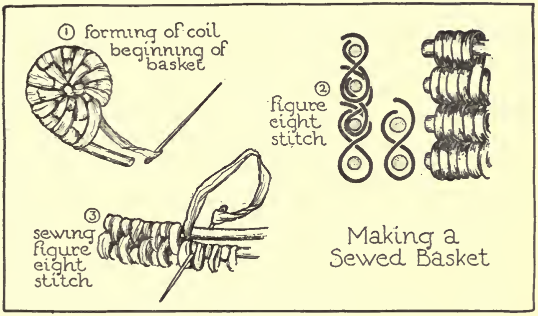
II

The Making of a Sewed Basket

We shall first make a design by folding and cutting paper as we did in making our design for the rattan basket. We should transfer the silhouette to another sheet of paper and make a decorative design with crayons or water color paints. We shall refer to Indian baskets or illustrations for suggestions.

In making a basket from rattan and raffia it is possible to employ one of several satisfactory stitches. The one which makes the firmest basket is the stitch known as *figure-of-eight*, so named because the raffia forms this figure as it passes in and out in the process of sewing. The basket is formed by coiling a piece of rattan, covering it with *raffia*, and at the same time sewing it to itself as the process of coiling progresses. The extreme end of the rattan, which has been thoroughly soaked, is first bent to the form of a hook. Then the raffia is wrapped about this hook and the coiling-sewing process begins. A fine tapestry needle (a large needle with a blunt point) is generally used for the sewing, and the raffia is split in order that the sewing may be facilitated. The raffia is used best when dry. The figure-of-eight is simply an over-and-under stitch, the progress of the needle being, (1) between reeds and into basket, (2) around outside reed and into basket, (3) around

inside reed and out of basket; and repeat. As we work let us read about the Indians, who still make beautiful baskets. (See poem at the end of this chapter; also Suggested Reading.)



Making a Sewed Basket

III

The Making of a Padded Box with Cover

The box will be cylindric in form, 4 inches in diameter and 3 inches high. It will be desirable to make a design before attempting to construct the box.

Let us make a drawing of the front and top views of the box as it will be when finished. We shall place the top view directly over the front view. What will be the shape of the front view? The top view? Let us use our compasses and rulers and make accurate full-size drawings. When these have been completed the decoration must be planned.

Upon the top view of the box arrange a border to emphasize the shape of the cover. The *motif* may be a small flower and bud or an interesting spot to be alternated with one of a different shape and size. The units should be carefully placed between the border lines and should be carefully spaced so as to appear to be placed just the right distance apart. The colors used should be harmonious. Let us try a complementary scheme, which may include any of the following combinations: blue and yellow-red (orange), green and red-purple, yellow and purple-blue, red and blue-green, or purple and yellow-green.

In making the box, observe the following directions:

(1) Provide yourself with a piece of heavy cardboard large enough to supply two 4 inch circles for cover and bottom.

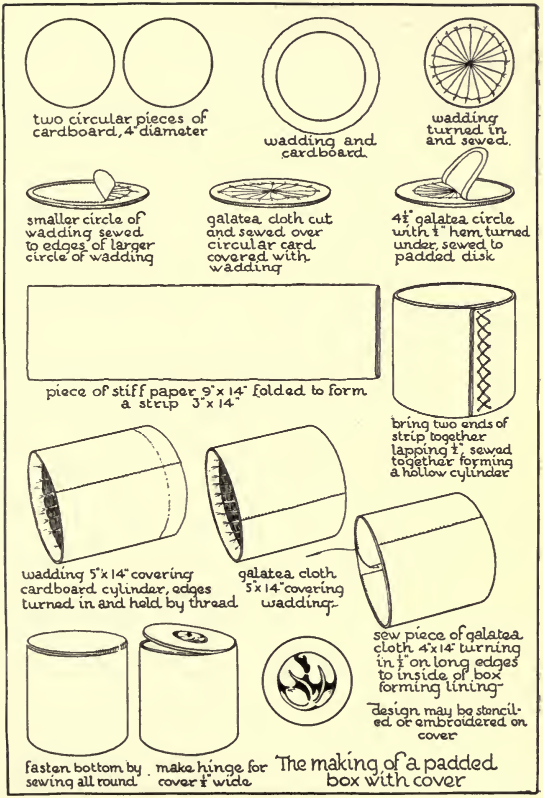
(2) Draw these circles with compasses, and then cut them out.

(3) Provide yourself with a piece of cotton sheet wadding sufficiently large to supply two 5 inch circles and two 3⅞ inch circles for padding cover and bottom.

(4) Mark these circles and cut them out.

(5) Place one of the cardboard circles on one of the larger circles of wadding. Let the wadding project equally all the way around. How wide will this strip of wadding be?

(6) Cover the cardboard disc by folding the



The making of a padded box with cover

wadding over it at its edge, entirely around. It will not stay folded, of course. It will have to be fastened with thread.

(7) Take needle and thread and sew from one edge of the wadding to the edge of the wadding at the opposite side of the cardboard disc, crossing the stitches each time, arranging your stitches like the spokes in a wheel.

(8) When you have sewed all the way around fasten the threads by sewing over and over. Then cut the thread.

(9) Take one of the smaller circles of wadding ($3\frac{7}{8}$ inches in diameter) and sew its edges to those of the larger circle of wadding which has been fastened in place. Both sides of the cardboard circle are now entirely covered.

(10) Cover the other cardboard circle in the same way.

(11) Provide yourself with a piece of brown galatea cloth, or other suitable material, for covering the two padded discs. The four circles cut from the galatea must have diameters of 5 inches and $4\frac{1}{2}$ inches respectively. How large a piece of galatea will it take to furnish two circles of the smaller size and two of the larger size? Prepare the piece of galatea.

(12) Cover one of the padded discs by sewing the 5 inch galatea circle over the disc just as the wadding was sewed before. The 5 inch galatea circle is placed over the $3\frac{7}{8}$ inch wadding circle, as this

will give a better appearance to the finished work.

(13) Take the 4½ inch galatea circle and turn under a hem ½ inch in width.

(14) Sew this circle in place, thus entirely covering the padded disc with galatea.

(15) Transfer your decorative design to the other 5 inch circle of galatea by tracing. Use carbon paper placed face down upon the cloth. If you wish to preserve the original design, use transparent paper in making the drawing to be used over the carbon paper.

(16) Embroider the design with silk floss. An outline stitch or other simple stitch will be used. If you prefer you may stencil the design, using a brush and dyes.

(17) When the decoration is finished, cover the second padded circle with galatea. Both circles are now entirely finished.

(18) Prepare a piece of stiff paper, 9 inches by 14 inches, for the sides.

(19) Place this paper horizontally and measure down on each of its short edges 3 inches and 6 inches respectively, and place points.

(20) Connect the two points which are 3 inches from the upper edge by drawing a pencil line.

(21) Connect the two points which are 6 inches from the upper edge.

(22) Fold the edge of the paper nearest you to the pencil line farthest from you and crease.

(23) Fold the edge farthest from you to the

crease that you have just made, thus making the folded paper into a strip 14 inches long composed of three thicknesses of the paper.

(24) Bring the two ends of this strip together lapping them ½ inch and sew them together with needle and thread. This makes a hollow cylinder practically 13 inches in circumference and just 4 inches across.

(25) Prepare a strip of wadding 5 inches wide and 14 inches long.

(26) Lay the wadding on the desk and roll the hollow cylinder over it so that an equal amount (one inch) of the wadding projects at either edge.

(27) Bring the ends of the wadding together, tightly lapping and sewing them.

(28) Crease the wadding over the edges of the stiff paper, bringing its edges on the inside of the box.

(29) Using needle and thread, catch the two edges of the wadding and pull them securely in place on the inside of the box so that the wadding is perfectly smooth on the outside.

(30) Prepare a strip of the galatea 5 inches wide and 14½ inches long.

(31) Put this on just as you did the strip of wadding being careful to make a neat lap by turning under the extreme edge of the outside end of the material.

(32) Prepare a second strip of galatea 4 inches by 14 inches to serve as a lining for the sides of the box.

(33) Turn the long edges over ½ inch, making the finished strip but 3 inches wide.

(34) Place this on the inside of the box, with the half inch hems next to the side of the box.

(35) Sew the creased edges to the edges of the covered sides of the box and fasten the loose end of the strip down, turning the edge under as it is sewed in place.

(36) Fasten the bottom of the box on by sewing over and over all the way around. Take small regular stitches.

(37) Make a hinge for the cover by sewing the edge of the box to the edge of the cover. The hinge should be about half an inch wide. It is best to place it where the covering material has been lapped.

The Basket Weaver

No flashing loom is hers; no shuttle flies
To do the bidding of her hands and eyes.
No needle glides to designated place,
As weave her sisters overseas the lace.
Hers is a simpler workshop in the leaves;
This is a simpler pattern that she weaves,
Her woof the splinter of the forest tree,
The ash so white, the elm and hickory,
Her dyes the blood of marish weeds and bark
With tints as ruddy as her features dark—
These are her simple implements of toil,
The ready products of the woodland soil.

Yet who shall say her skill is aught the less
Than that of her who weaves the princess' dress?
For generations women of her race
Have woven baskets in this quiet place,
And she who weaves beneath the ancient trees
Reveals the skill of toilsome centuries.

. . . .

So, through its time, the basket that she makes
Shall sing to me of brooks and sylvan lakes,
Shall sing the glory of the vanished Red,
Shall sing a requiem for peoples dead,
Shall sing of tree, of flower and of sod—
Shall sing of Nature and the place of God.

DOUGLAS MALLOCK.

From "In Forest Land." *The American Lumberman*, Chicago, 1906

EXERCISES FOR STUDY AND REVIEW

(1) Which food products usually come from the store in paper boxes? Why are these products packed in boxes?

(2) Bring some small paper boxes to school. Make a careful pencil drawing of one of these.

(3) What is corrugated paper? Make a sketch to show its construction.

(4) What advantages for use have corrugated paper boxes over wooden boxes?

(5) Why is reed used in the making of furniture? In the making of baby carriages?

(6) What advantage has rattan over willow as a basket weaving material?

(7) "The Basket Maker", from a painting by Margaret Shepard, shows a Hopi Indian making a sewed basket. Write a short story of Indian life for which this half-tone reproduction might be used as an illustration.

(8) Why are most candy boxes shallow and most cereal boxes deep?

(9) What are some of the qualities that a maker of paper boxes should possess? How much can a beginner earn in a day? In a week? How much can an expert earn?

(10) How are wooden berry boxes made?

(11) Make a pencil box from heavy construction paper. Work out your plan first on manila paper.

Suggested Reading about the Making of Baskets and Boxes

Bush and Bush.—*Industrial and Applied Art Books*, V, VI, VII, VIII. Atkinson, Mentzer & Company.

Buxton and Curran.—*Paper and Cardboard Construction* (See *Boxes*). Manual Arts Press.

Eppendorff.—*Handwork Construction* (See *Basket Making*). Pratt Institute.

Glauflin.—*Handicraft for Girls* (Chapter XII, *Basketry*). Manual Arts Press.

Holton and Rollins.—*Industrial Work for Public Schools.* (*Raffia and Reed Baskets*). Rand McNally & Company.

James.—*Indian Basketry and How to Make Baskets.* Malkan.

Moseley.—*Trees, Stars and Birds* (Index under *Baskets*). World Book Company.

Rodgers and Others.—*Trade Foundations* (Index under *Paper Box Making*). G. M. Jones, Indianapolis.

Snow and Froehlich.—*Industrial Art Text Books*, V, VI, VII, VIII. The Prang Company.

Talbot.—*How to Make Baskets.* Doubleday, Page & Co.

Toothaker.—*Commercial Raw Materials.* Ginn & Co.

Turner.—*The Basket Maker.* Atkinson, Mentzer & Co.

White.—*How to Make Baskets.* Doubleday, Page & Co.

——— *More Baskets and How to Make Them.* Doubleday, Page & Co.

Loading Cars with Shale

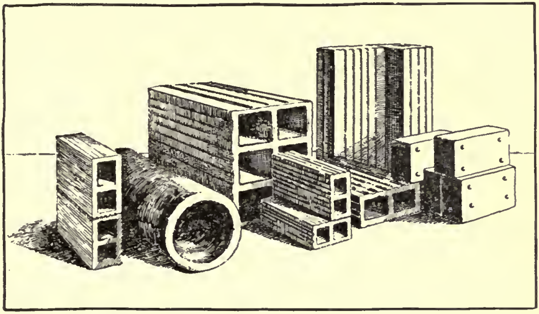
IV

BRICK AND TILE

A brick is a molded rock-like product which has been formed into a shape convenient for use in building walls. The making of our native clay brick is confined to those localities where material suitable for its manufacture is found. For this reason the industry is not evenly distributed over the United States. Pennsylvania ranks first in the production of brick and tile; and Ohio, Illinois, New York, and New Jersey, follow in the order named.

That brick and tile are permanent as building materials is demonstrated by the excellent condition in which we find many of the ancient brick buildings of Europe. Old bricks found at Bismaya, in the valley of the Euphrates River in Asia, are still in almost as good condition as they were when the buildings were constructed forty-five hundred years ago. Brick is the oldest artificial building material. From the earliest

times the inhabitants of Samaria, Chaldea, and Egypt built houses of *adobe*, which is sun-dried brick. We find that the kings of Chaldea and the Pharaohs of Egypt lived in brick houses, and that King Nebuchadnezzar of Babylon built



Hollow Tile, Drain Tile, and Paving Bricks

his palaces and temples of brick. Brick can lay claim to an extensive use in medieval times. It was during the thirteenth century that the industry as we know it to-day began to flourish in the north of Europe.

The western world too can boast of its ancient brick remains. When the Spaniards came to America they were surprised to find among the Incas and Aztecs buildings and monuments made of brick. In the early days of the thirteen colonies, small amounts of brick were imported; some were probably brought in the bottoms of

ships as ballast. Many of the first brick houses erected in America were built of bricks imported from European countries.

The beginnings of the clay working industries in the United States are given by one authority as follows: Virginia, 1611; Massachusetts and New York, 1629; Maine, 1635; North Carolina, 1663; Rhode Island, 1680; and Pennsylvania, 1683.

The varieties of brick and tile made to-day are numerous. The most important are:

Brick	Tile
1. Common	1. Drain
2. Face	2. Sewer
3. Paving	3. Roofing
4. Enamel	4. Decorative
5. Fire	5. Building (hollow tile)

The manufacturing processes used in the production of handmade bricks may be separated into two main divisions: (1) Preparation of the clay, which involves the operations of *washing*, *tempering*, and *pugging*, and (2) the formation of the bricks from the washed, tempered, and pugged clay, which involves the operations of *molding*, *drying*, and *firing*.

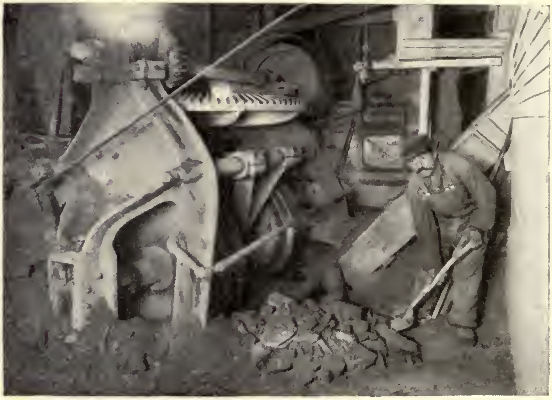
The purpose of the washing is to separate stones and other foreign matter from the clay. It is done in a *wash mill* which consists of a large tank, about fourteen feet in diameter, in which a set of paddles revolves at the rate of nine or ten

revolutions a minute. This churning causes the clay to be mixed with the water forming a *slip* (clay and water in a liquid state), which is allowed to run off while the stones sink to the bottom. From twenty to forty cubic yards of the material can be thus washed by one wash mill in a day.

Cars Lcaded with Shale Going up Incline to Dry Shed

Sometimes the clay is obtained in the form of *shale* or is hard and lumpy so that it has to be dried and crushed before it is mixed with water. Crushing is accomplished in a *drypan* or *pan mill* equipped with *edge rollers*. The pan mill consists of a circular iron pan, six to eight feet in diameter and perhaps one foot deep, in which a pair of heavy wide wheels are caused to roll. These wheels or rollers move in a circle just inside the

edge of the circular pan. The wheels are called *edge rollers* because they have a narrow tread which provides a cutting action in crushing shale which is ground while dry. Much grinding and crushing is often avoided by exposing the clay to the action of the weather for a considerable



Feeding a Drypan

length of time before any attempt is made to work it.

After the clay has been washed it is *tempered.* Tempering consists in mixing water with the clay and working the two together until a paste of fairly uniform consistency is formed. The best results are obtained when the clay is tempered for two days before it is pugged.

Pugging is a further process of mixing which is employed to reduce the clay to a thoroughly plastic mass. This operation is accomplished in a *pug mill*, which consists of a vertical cylinder containing a shaft to which knives that revolve are attached. The tempered clay, having been thrown in at one end of the cylinder is cut and mixed by the knives as it works its way down through to the lower end. The pugged clay is finally discharged ready for molding.

Two methods of molding bricks by hand are now in use: *slop molding* and *sand molding*. In slop molding, the workman makes a lump of clay approximately the size and shape of a brick and dashes it into a wooden mold, which has been first dipped into water so that its inside is wet. He then presses the clay into the mold and fills it completely, using a rammer called a *plane*. The plane is a small flat board with a handle. The clay not needed is removed and an even surface is produced by drawing a straight edged strip of wood, called a *strike*, across the top of the mold. The contents of the mold are now turned out on the *drying floor*.

Sand molding is quite similar to slop molding, except that in sand molding the mold is dipped into damp sand instead of water, so that a coating of sand is deposited on its inside. The purpose of the dipping, in both cases, is to prevent the clay from sticking to the mold.

Gerrit A. Beneker, © 1919 *Hydraulic Steel Co.*

MEN ARE SQUARE

Machine molding is rapidly replacing hand molding. In molding by machine, the clay is placed in a large cylindric tank into one end of which a *piston* is forced which causes the clay to be squeezed out at the other end through a rectangular opening which is exactly the same

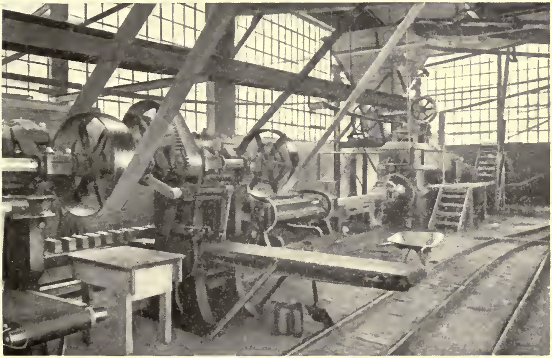


Photo by Beitt

Making Wire-cut Bricks by Machine

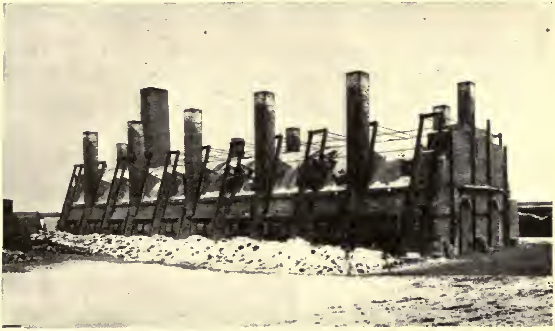
size and shape as the largest face of one of the bricks to be made. The clay comes out in the form of a continuous bar which is deposited on the cutting table. Here a frame, carrying a number of wires spaced just as far apart as the thickness of the brick, is drawn down on the bar of clay, and the wires passing through it cut it into bricks. Bricks manufactured bv this method are called *wire-cut* bricks.

The bricks must be thoroughly dried before being baked or *fired*, because the moisture contained in them would otherwise produce steam which would cause them to explode when heated. They are first placed in racks for drying, one tier above another, and are set on edge in rows and spaced about five inches apart in order that the air may circulate around them. The racks are covered with an improvised roof of rough boards to protect the bricks from rain. Sometimes the racks are enclosed in carefully built sheds. When the bricks have dried sufficiently to be handled, they are *skintled*, or set still farther apart and placed diagonally to allow the air to pass between them more freely.

When thoroughly dried, the bricks are fired in a *clamp* or in a *kiln* (the more modern way). A clamp is formed by piling the bricks so that there are passages in which the fuel is placed. Large passages extending through to the outside are left to serve as *flues*. The fuel consists of cinders or of coke distributed in the interior passages. The flues are filled with fagots which are lighted from the outside and which soon ignite the coke. The fagots are kept burning for a day or so and are then removed and the mouths of the flues stopped with additional bricks plastered over with clay. The clamp is allowed to burn until all the fuel has been consumed. This usually takes from three to six weeks. The

clamps are then torn down, and the bricks sorted and piled ready for shipment.

A modern brick kiln is a large oven-like structure with an arched roof and a tall stack for creating the necessary draft. It is built of brick and is lined with fire brick. (Fire brick is



A Modern Rectangular Brick Kiln

made from new clay mixed with *grog*, clay which has been fired and ground.) The bricks to be fired are piled in the kiln chamber in such a way that the burning gases from the fire may circulate between them. A fire box is located under the kiln chamber. The fuel used is generally bituminous or soft coal, which when burned sets free a gas that is itself burned within the chamber. Two kinds of kilns are used: the *up-draft* and *down-draft* types. In the up-draft kiln the

flames are allowed to pass directly up through the bricks from the bottom to the top of the kiln, while in the down-draft kiln, the flame does not come in contact with the bricks until it has reached the top when it pours down through the bricks to the flues. A temperature of 1,200 degrees Fahrenheit is maintained in the kiln.

Roofing tiles are usually made from a high grade of red clay. As it is necessary that these tiles be nonporous, they are fired at a higher temperature than are the common red bricks.

Making Bricks and Building a Toy House

Make little bricks from clay. Use clay from nearby fields if you are able to find some. From these bricks construct a small house.

The house is to be built with solid side walls, windows and doors in front and back, and a sloping flat roof. It is to be rectangular in *plan*, and one side may be left open.

Teacher's Note: The class should be divided into groups, each group being held responsible for a particular part of the work, yet enough freedom should be permitted so that each pupil benefits by the others' work. The spirit of competition will be conducive to better effort. The following groups are suggested: 1. Clay diggers and mixers. 2. Molders. 3. Driers and firers. 4. Masons. 5. Carpenters.

Plan the house by drawing a floor plan. Make your plan for a real house of full size and draw it to such a scale that ¼ inch on your plan represents 1 foot on the full size house. Build your house on the scale of 1 inch to a foot. This means that every

dimension which would be 1 foot on a real house will be 1 inch on the house planned by you.

The building of the house should be done outside the school house if possible, and here the real work begins.

1. *Work of clay diggers and mixers:* Dig the clay (a small cart load will be sufficient for the whole project). Grind and mix the clay in a wooden mixing box in which an improvised narrow tread roller may be run back and forth. Such a roller can be made by casting a concrete wheel and providing it with a suitable handle for moving it about, or a discarded iron wheel of some sort may be used. The mixing box for the clay will be built by the carpenters and should be of simple construction. Mix the clay with water until it is quite plastic.

2. *Work of molders:* First construct, with the aid of the carpenters, a number of molds. These may be either *unit* or *multiple* molds. In either case they should provide a box form for the brick which will be ½ inch thick, 1 inch wide and 2 inches long. The bottom should be removable, and a *pusher* provided just the size and shape of a brick. By means of this the clay may be pushed from the mold. Mold the bricks by pressing the mold full of clay, packing it well and pushing out the newly formed brick. Give the bricks to the driers and firers.

3. *Work of driers and firers:* Take the bricks

from the molders, spread them on a board and allow them to dry in the sun. Then pile them in arch-like piles, preparatory to firing. Build fires under and around the arches and feed the fires until the bricks have been properly hardened. It will be necessary to bring them to a red heat and to keep them at this temperature for perhaps an hour.

4. *Work of masons and* 5. *of carpenters:* These groups should work together. Stake off the area for the building. Mix cement mortar. (It will be best to use portland cement only for this; for while both sand and cement are used in practical work, it will be found difficult to get satisfactory results in such small work if sand is used.) A mixture of cement and water is known as *neat cement*. Lay the bricks, *breaking* joints; that is, arranging them so that the joints on the second layer of brick are over the middle of the bricks below, those of the third layer or *course* being directly over the middle of the bricks in the second course, etc. Avoid using too much mortar. Carpenters will make the window frames and door frames (which may be simple frames of the sizes desired). Carpenters will help masons set the frames in place. The first floor may be left a dirt (soil) floor. Make the second floor of a single board, and set it in place at a proper height on a ledge provided by laying bricks on edge instead of flat in this course, thus leaving a difference in the thickness of the wall of ½ inch, which will provide the proper ledge on the inside. The

floor board should be approximately 1 inch thick (the same as the height of this course of bricks) so that the next course may be laid flat and will rest on the brick and the floor board.

Make the roof of a solid board and cover with sanded tar paper.

THE BUILDER

I am the builder; on my throne
Of iron and wood and steel and stone,
I stand the Builder, but not alone:—
In God's own image, from God's own plan,
From common clay, He built Me—Man.
From common clay, He raised the ban,
That I might live—but not alone.

From God's own earth I scoop the ore,
The coal I mine, the rock I bore,
The lightning's flash from the air I store:—
This clay fuse I—with fire to mock
The Ancient Gods; their temples rock,
Crash back to earth: tongues interlock
To build no Babel as of yore.

Where once a hillock was but small
I build the city towering tall,
The peasants' hut, the marble hall:—
With men from many a foreign strand,
I build with heart and soul and hand
America—The promised Land!
Build all for each, build each for all.

GERRIT A. BENEKER

This poem is used by courtesy of the author and of *The Red Cross Magazine*

Exercises for Study and Review

(1) Compare the modern method of brickmaking with that followed by the ancient Egyptians and American Indians who used adobe in building.

(2) What kinds of bricks are best for building, for paving streets, for lining tanks?

(3) Compare brickmaking with pottery making, considering the quality of the clay used, shaping the product.

(4) How do porous tiles differ from nonporous in appearance, in method of manufacture?

(5) "Men Are Square." Give your opinion of the workman painted by Gerrit Beneker.

(6) Should drain tile (tile used in draining land) be porous or nonporous? Why?

(7) How are bricks formed by machine?

(8) Why should newly formed bricks be thoroughly dried before firing?

(9) Draw two diagrams to show the difference between the up-draft and down-draft types of brick kilns.

(10) Is bricklaying a skilled trade? Why do you think so?

(11) If you were to build a house of common red brick what color would you have the shutters, the doors, the veranda posts and railings? Why?

Suggested Reading about the Making of Brick and Tile

Bishop and Keller.—*Industry and Trade* (Index under *Clay Industry*). Ginn & Co.

Brown.—*Hand Brickmaking*. Clayworker Press, London.

Bush and Bush.—*Industrial and Applied Art Books*, V, VI, VII, VIII. Atkinson, Mentzer, and Company.

Chamberlain.—*How We Are Sheltered* (Page 110). The Macmillan Company.

Dobson.—*Rudimentary Treatise on the Manufacture of Brick and Tile*. Crosby Lockwood, London.

Rodgers and Others.—*Trade Foundations* (Index under *Brick, Bricklayer, Brickmaking*). G. M. Jones, Indianapolis.

Scrimshaw.—*Bricklaying in Modern Practice*. The Macmillan Company.

Searle.—*Modern Brickmaking*. D. Van Nostrand Company.

Snow and Froehlich.—*Industrial Art Text Books*, V, VI, VII, VIII. The Prang Company.

Tarr and McMurry.—*New Geographies, Second Book* (Index under *Brickmaking*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials*. Ginn & Co.

Wells.—*How the Present Came from the Past*, Book Two (Index under *Brick, Masons, Terra Cotta*). The Macmillan Company.

Pottery of Indian and of Greek Design Made by College Students

V

THE POTTERY INDUSTRY

Since wet clay can be worked into various shapes on account of its doughlike condition and can be hardened by means of fire, it has been used by all primitive people in the potter's craft. Clay is made up of minute particles which cling together when moist but which are easily separated when dry. If we stir dry clay dust into a dish of water we shall find that the small particles will become suspended in the water. Besides the free water which clay possesses it also contains a small amount in combination, which, when once dried out by fire, can not be replaced. Clay once burned never regains its plasticity. Sun-dried or adobe bricks are not permanent in a moist climate. Burned bricks however are practically imperishable even when exposed to the weather.

Clay is found in all stages of purity. It is often combined with sand, iron, or vegetable matter so that it is not fit for use. *Kaolin* is the purest

form. *Ball clay* (clay containing more impurities than kaolin) is used extensively in the making of table dishes.

Various means have been used for separating clay from its impurities. Most of these depend upon the principle that the small particles can be suspended in water and thus carried away from other substances which are heavier and will therefore sink.

All clay fired at a low temperature is porous; that is, it absorbs water. The same clay fired at a higher temperature *vitrifies;* that is, becomes glassy and no longer absorbs water. All clay products can be classified as *porous* or *vitrified.* Brick, terra cotta, drain tile, roofing tile, wall tile, flower pots all have a porous body. Table ware may be either porous or vitrified. Porcelain is vitrified.

Pottery may be glazed or unglazed. Glazed pottery, which may be divided roughly into two classes, the once fired and the twice fired, considered from design and decoration standpoints, forms by far the most important group of pottery products.

Stoneware is a pottery made from either light or dark clay. It is glazed on the unburned body either before setting in the kiln or by means of salt during the burning process, and is burned to a dense, hard condition.

Porcelain is a white vitrified, translucent ware,

Courtesy of Lenox, Incorporated

White House Service of President Wilson

The first White House Service designed by an American artist, made chiefly from American clays at an American pottery and decorated by American workmen. Frank G. Holmes, designer.

Courtesy of Lenox, Incorporated

Belleek China
Autumn Pattern
Designed by Frank G. Holmes

in which the body and glaze are brought to completion and maturity at one and the same burning, which takes place at a very high temperature.

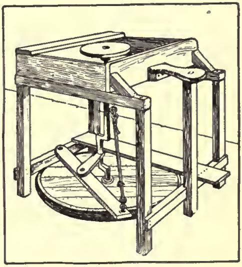
China is a ware similar to porcelain in appearance, though scarcely as white, produced by a double burning in which the body is brought to its density and translucency before glazing, the glaze being added subsequently and fired at a lower temperature.

Bone china is a variety of china in which calcined bone is used as an ingredient, constituting about forty per cent of the mass.

Belleek, named from the town of Belleek on the west coast of Ireland, is a variety of china, in which as to

the body, feldspar predominates, imparting a creamy color; it is glazed with an extremely fusible compound consisting largely of lead oxide.

Earthenware is a white or nearly white body produced like china, by two burnings, but in which the body remains porous in varying degree according to the temperature employed. The glaze is similar to that used for china, but chiefly made from the cheaper materials.



THE POTTER'S WHEEL
The operator sits astride the saddle-like seat and whirls the disk by moving the lever back and forth with his left foot.

Vitreous ware and *semi-porcelain* are "fancy" names applied, often without justification, to the varieties of earthenware as they approach more or less the composition of china. There is no essential difference between these wares and earthenware.

Faïence is fine glazed earthenware used for ornamental and decorative purposes. Usually there is no attempt to produce a white body and the glazes are frequently colored.

Majolica is a subdivision of faïence and is generally considered to include those wares on which the glaze has been made opaque by the use of the oxide of tin.

The most primitive method of making pottery is by the hand method of building. Coils of clay are wound around, one on top of the other and *welded* together by pressing, the clay first having been worked to a soft or plastic state by mixing with water. The dish is shaped and smoothed by hand. (See illustration on page 126.)

When vessels of circular form were to be made the *potter's wheel* was formerly employed, although today it is used only in the art potteries. When this method is used, the lump of clay is placed on a revolving horizontal disk, and shaped by the hands of the potter who keeps his hands moist by dipping them frequently into water. The water keeps his hands from sticking to the revolving lump of clay. After the vessel has been removed from the wheel and has become partially dry, it is sometimes further perfected by means of turning on a lathe, sharp tools being used in refining the shape of the damp dish or vase as it revolves. Handles and spouts are put on the vessels before firing by sticking them on with slip while the parts are still moist.

It is probable that the Egyptians invented the potter's wheel. At any rate we know that they were using it at a very early period in history. The ancient Greek vases were beautiful because of their richness and simplicity of color, excellent proportions and contours, and the refined quality of their decorations which were

most appropriate, being formed by harmonious lines and agreeable spaces. The vases usually had handles. Red clay was used almost entirely. In the black-figured ware the natural red surface of the dish served as a ground, the figures being painted in black. In the red-figured ware the figures were first sketched in black outline and the background filled in with black. Details of face and costume were put in on the red with a fine black outline. The black-on-red figured ware is usually less attractive than the red on the black background which came to be used more and more until the earlier method finally disappeared entirely.

Casting is today often employed when pottery of a high quality is desired and when the walls are to be very thin. Clay in the form of slip is poured into plaster of Paris molds. The plaster of Paris absorbs the water, thus causing a thin coating of clay to be deposited all around on the inside of the mold. When the deposit is thick enough to form the walls of the vase, the remaining free slip is poured out, leaving the wet piece of ware on the inside of the form. After this partially dries and shrinks somewhat, it is removed from the mold. This is simplified by the fact that when necessary the molds are so constructed that they can be taken apart. When the piece becomes thoroughly dry it is smoothed and prepared for firing. It is placed in a fire clay

box called a *sagger* which protects the piece from the flames and gases just as an oven protects a

Courtesy of the Rockwood Pottery

Placing Saggers in the Kiln

loaf of bread. The saggers are placed one on top of the other in a *kiln*. The kiln is a large box-like structure built of fire brick and surrounded

by flues in order that the fire may entirely surround the dishes and yet not actually come in contact with them, as smoke would discolor them.

© *Underwood & Underwood*

Dipping Bisque Plates in Glaze Preparatory to Firing; Worcester, England

Most dishes are fired twice. The first firing is called the *bisque* firing and the piece of pottery once fired is called a *biscuit* or bisque piece.

The biscuit is now *glazed*. A glaze is a glassy covering placed on wares to beautify them and to make them more serviceable. Glazes usually contain a metal which gives them their color. Iron gives red; copper, green; cobalt, blue; etc. Glazes contain silica which is often just sand ground fine and is the main ingredient used in making glass. Other things used in making glazes are lead oxide, calcium oxide, zinc oxide and alumina. Clay and feldspar are also used in glazes. The various materials are ground together with water to a fine milky condition. The biscuit is then dipped into this and comes out covered completely. When fully dry the ware is again placed in the kiln and fired to a heat high enough to fuse the *glaze mix*. At this temperature the various materials combine and make the finished glaze.

The processes involved in the manufacture of modern glazed ware may be enumerated as follows: preparing the clay, preparing the glaze, modeling and moldmaking, forming the ware, drying the ware, sagger making, placing ware in the saggers, placing saggers in the kiln, firing the bisque ware, cleaning the biscuit, selecting and grading the ware, stamping, underglaze decorating, dipping in glaze, placing dipped ware in the saggers and the saggers in the glost kiln, firing glazed (glost) ware, overglaze decorating, firing in the decorating kiln. Stoneware and

porcelain are produced in a single firing. They must, however, receive a second firing for *overglaze* if decoration is to be applied over the glaze.

The preparation of the clay involves weighing, slip making, filter pressing, and pugging. A man weighs the dry clay by shoveling it from the bins into a car which weighs it automatically. When the scales balance he shoves the car to the next bin and to the next until it reaches the mixer. Then he dumps the clay into the hopper of the mixer which mixes the dry clay powder in water to the consistency of rich cream. From the mixer the slip runs through a lawn sieve and over magnets which remove the iron. A man cares for the sieve and keeps it washed clean and in good condition.

From the sieves the slip is pumped into canvas bags which arranged in a row, horizontally, constitute a *filter press*. The bags retain the particles of clay and allow the free water to percolate through their meshes. One man cares for each filter press. The moist clay is now fed into a *pug mill* which forces the air out of it and makes it plastic.

The materials used in making the glaze in most commercial establishments are weighed out by the foreman and mixed by a laborer who generally knows nothing about the composition of the glaze. One of the chief constitutents of glaze is *frit*. The materials used in the mak-

ing of frit are first ground in a mill, then weighed by a foreman and mixed by an unskilled laborer who puts the mixture into a sagger for firing. When it has been fired, the frit comes back as a piece of glass firmly attached to the sagger, from which it must be broken. The sagger has to be sacrificed.

No report on the workers employed in the production of pottery is complete without mention being made of the modeler. Model making is a most essential phase of pottery manufacturing; yet one man can handle the entire field of modeling in most factories.

The *modeler* makes the models or patterns by means of which molds for plates and hollow ware are made. He makes them from clay or from plaster of Paris and sometimes from clay and plaster combined. He also makes the models for handles and the other irregular appendages found on some articles of pottery. He turns the regular cylindric and spheric forms and sometimes even the oval forms on a *lathe* or *whirler*. Models for irregularly formed hollow ware such as pitchers and some bowls must be worked out entirely or almost entirely by hand.

From the modeler's model the *mold maker* casts a *block mold* by means of which the casters or pressers may produce the part in clay. The block mold is used rather to serve as a form for casting a *case mold*. It is by means of the case

mold that the mold maker is able to cast as many working molds as he needs. The *working mold* is exactly like the block mold, but it serves a different purpose.

The modeler has to possess considerable artistic taste. He must be able to employ graceful lines and to indicate structural growth. He must also have a good sense of proportion. Sometimes he models in the plastic clay; sometimes he carves the plaster in a dry or in a semimoist condition; sometimes he produces a form by turning it on the whirler or the lathe. Often several methods are involved in the making of a single model. The problem is brought to the modeler in a variety of ways. He may work from a dimensioned drawing or from a sample.

Plates and flat dishes both round and oval are formed over a plaster form which whirls. The machine used is called a *jigger*. The jiggerman's helper throws a lump of clay on a wet plaster slab in order to flatten it, and then throws over the plaster form the flat clay disk thus made. The clay disk is called a *bat* and the process of making a bat is called *batting out*. When the clay ball is thrown on the plaster it clings to the plaster form over all its surface all the way round. When the form with the clay bat on it is made to whirl, the jiggerman lets down on the bat a *templet* which shapes the outside or the back or bottom of the dish or plate. Bowls and cups are made, with-

out their handles, on jiggers. The plaster form in this instance shapes the outside of the ware whereas the templet shapes the inside. In oval jiggering a special device on the machine makes possible the regular formation of shallow and hollow ware.

Courtesy of Onondaga Pottery

OPERATING A JIGGER

At the right will be seen the bat of wet clay inverted over the plaster of Paris form. The plaster form has just been removed by the worker who has the handle raised ready to lower it over the next clay bat.

Casting is always employed when hollow ware of irregular shape is to be made. Handles are either cast or pressed as are also all small irregularly shaped flat dishes. In pressing, the plastic clay is pressed into or between plaster of Paris forms.

After the dishes or appendages (handles and the like) are received from the jiggerman or the *caster* or the *presser*, they are finished by a worker who scrapes off their rough edges. The cups are turned smooth on a *mandrel*. Sharp tools made of soft steel are used in the turning. The dishes now go to the spongers, young girls, who smooth them with moist sponges. If handles

are to be put on, the dishes go to the handlers, who stick the handles on with slip and sponge around the points of contact. The dishes are now taken to the drying room on boards and allowed to dry thoroughly.

A *sagger* is a receptacle made of *fire clay* and used to protect the ware from the flames and gases while it is in the kiln. Fire clay is made from new clay mixed with other clay which has been fired and ground fine. Saggers are generally made in two parts. In making them a slab of the fire clay is flattened out for the bottom and then a second slab is flattened for the sides. The walls of the sagger (before firing) are about an inch thick. Saggers somewhat resemble wash boilers in shape. They are assembled over wooden forms by the *sagger maker* and his helper. The bottom and sides are stuck together with slip. The standard sagger is about twelve by twelve by twenty-four inches. Newly made saggers are fired in the top of the kiln above those already in use.

The dry ware is packed in the sagger in a mixture of sand and dry clay (*peach clay*) which prevents the walls of the dishes from warping in the fire. One man piles the plates in *bungs* or stacks and places the dry mixture between the plates and another man sets the bungs in the sagger.

A kiln generally holds about two thousand saggers. They are carried to it and stacked up,

one on top of the other, by the kiln placers who carry the saggers on their heads in order to facilitate entering the narrow kiln door. A coil of moist clay is placed along the rim of each sagger. When the next sagger is placed on top of it, the one below is thus sealed from the gases which would discolor the ware.

The temperature for firing bisque china ware is about 2262 degrees Fahrenheit. The firing takes about fifty hours from the time the saggers are placed until the desired heat is reached. The kiln takes from two to three days to cool. Coal and natural gas are the fuels commonly used.

The bisque ware, when taken from the kiln, is rubbed with pieces of hard wood. In this way the sand and clay adhering to the surface are removed. This work is extremely dusty. In most plants it is done by women. After cleaning, the heavy ware such as is used in hotels is placed in a tumbling mill which tumbles the dishes over and over with fragments of broken ware much as clothes are tumbled in a revolving washing machine. This frees the surface of the ware from the bits of clay adhering to it.

When the dishes have been glazed an inspector examines each piece and strikes it with a piece of steel to detect cracks. All pieces are classified by him as of first, second, or third quality.

If the ware is to be without decoration it is

dipped in the glaze at once after firing. If it is to be decorated under the glaze, the design is transferred to the ware and the under glaze bands and lines are put on with the brush before the

Courtesy of Onondaga Pottery

Decorators Applying Line and Band Patterns

ware is dipped. Colored lines and bands are put on the once-fired ware with a brush. Each dish is spun round on a *whirler* as the decorator applies the color. A man dips each piece of undecorated or decorated ware separately into a tub of slip formed by the *glaze mix* and water.

Less heat is used in firing glost than in firing bisque ware and, in *glost firing*, the dry clay and sand are not used between the dishes in the saggers. The inside of the sagger used for glost ware is fitted with nonfusible china pins stuck into the sides for holding and suspending each plate separately. There is a hub in the center of the sagger which also carries suspending pins to support the edges of plates. Small pieces of ware are placed in the center of the sagger and wherever there is room about the plates and saucers.

Most of the tableware used to-day is decorated. This decoration is often accomplished by the use of colored glazes and also by overglaze colors as is the case in china painting. Good designs are those which are well adapted to a flat surface and which therefore are not naturalistic. They should emphasize the shape of the dish. In other words, the dish should be made to look stronger and more beautiful because of its decoration. It should not look less like a dish. If the decoration does not accomplish this it had better be omitted.

Practically all the porcelain ware used in the United States is imported. America produces to-day as fine chinaware, however, as is made anywhere in the world. Our china product includes what is known in the trade as *dinner ware* and *hotel ware*, the making of which has been described above.

Dinner ware is lighter and not so strong as hotel ware which is made to withstand washing in the dish washing machines used in hotels.

It will be remembered that china resembles porcelain in appearance. In making china, two firings are required while porcelain requires but one. Dinner ware and hotel ware are decorated in practically the same manner except that the designs are applied to the biscuit in the case of hotel ware and generally to the glazed dish in the case of dinner ware. In both instances the same method is employed in transferring the decorative patterns. Perhaps you have at some time used *decalcomania* transfers. These are still offered for sale in some toy stores. You may be able to get some to bring to school. Decalcomania transfers are used extensively in advertising. Signs are often put on glass windows by means of decalcomania.

Before describing the exact manner of transferring designs it will be interesting for us to observe the *designer* as he produces a design. We will imagine that he has before him the task of creating a new decorative pattern for dinner ware. Before going to work upon his design he makes a careful study of the market. He visits department stores and the art museum and he reads the trade journals in order to determine the character of his proposed design which must not only be as beautiful as possible but must also

be in the prevailing fashion to be a good seller. There is always a prevailing fashion in dinner ware just as there is a prevailing fashion in dress. At one time black stripes, little red flowers, and gold bands may be in vogue, and at another time blue birds and green leaves may be popular.

The designer makes several small sketches from which he chooses the one which he believes to be the most appropriate. This he draws in careful detail upon a piece of special paper into which there has been impressed in slight relief the form of a plate. He divides the *circumference* of the plate into four equal parts and he continues his pattern along the rim over one quarter of the plate's circumference. When he has finished his drawing in pencil outline he colors it with opaque water color.

The *print* method of transferring designs to dishes is a simple process by which ceramic colors instead of ink are printed upon a special paper called printer's tissue, and transferred from this paper to the ware. In producing these prints the designs are engraved by hand upon a copper plate. Then they are printed on the printer's tissue just as visiting cards are printed from the copper intaglio plates.

Lithographed *decals* (decalcomania patterns) are produced by printing from the surface of smooth, flat stones. The lithographing process is quite difficult to understand. It is based on the

fact that certain substances on the surface of the specially prepared stone plate act as a *resist* to the ceramic color which is used in the place of ink.

The print and decal papers are pressed color side down on the ware and when the paper is washed away the pattern remains. When a single color is wanted the engraved plate or print method is used. When more than one color is wanted the decalcomania method is generally used, although two colors and sometimes three are successfully reproduced by means of engraved copper plates.

Courtesy of Onondaga Pottery

Decorators Applying Print Pattern (Transfers) in One Color

I

The Making of a Vase

PREPARING THE CLAY

It is possible that clay suitable for the making of dishes may be found in the vicinity of our school building. Let us look for it. The clay soil may be brought into the schoolroom in

lumps which we shall break in order to remove the large stones and roots. It is now put in a large pail partly filled with water and stirred. The mud having been thoroughly mixed to the consistency of thick cream, it is poured through a screen into a second pail. The small stones are in this way removed. An ordinary window screen may be used, although a finer sieve is desirable. After being left over night, the clear water is poured off and the clay that has settled is spread out in the sun to dry sufficiently for use. Before being used, however, it must be made plastic by being worked for a few minutes in the hands.

The clay may, if it is desired, be put through the screen dry. This method, although not according to industrial practice, will be found better adapted to school conditions.

MAKING THE DESIGN

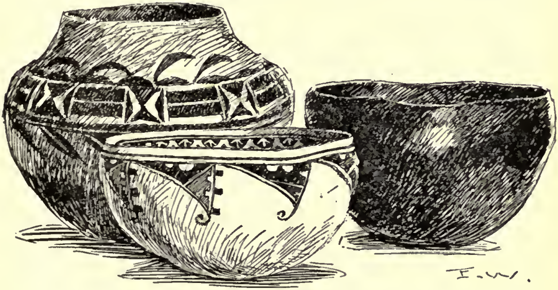
Refer to pages 125 and 127 for suggestions.

Designs for vases are worked out in school by folding and cutting paper. In this way silhouette patterns are produced. The shapes planned must be simple, the sides kept nearly vertical. The silhouette is transferred to drawing paper tinted to match the color of the clay after it has been fired. A decorative border or surface design involving the repetition of a unit may be worked out with colored crayons or with opaque water

color paints. The colors used may be (1) the color of the clay after firing, (2) orange (yellow-red), (3) red, (4) black.

FORMING THE VASE

The vases are made by building with clay *coils* rolled between the hands and the desk top;

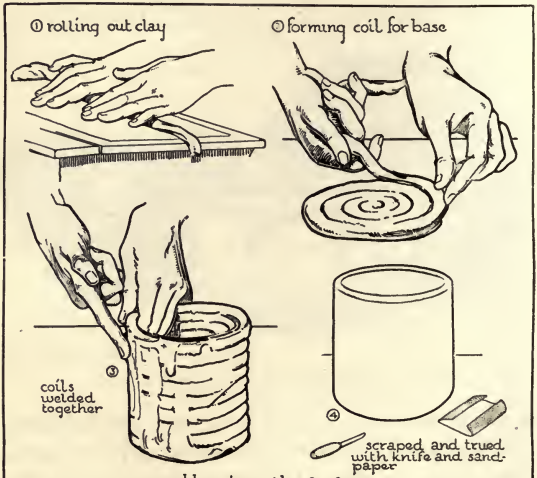


Courtesy of the artist, Ellsworth Woodward

Clay Utensils Made by the American Indians

we shall protect the desk by a sheet of linoleum, a board, or a piece of heavy paper. A paste-board disk having the same diameter as the base of the proposed vase is used as a guide in starting. This is covered with coils of clay wound around in a spiral and pressed together to form a disk about one-fourth of an inch thick. The building of the walls is accomplished by this spiral arrangement of coils which are welded together by being pressed firmly against the

ever growing wall. The clay should be kept plastic. If the walls become unsteady because of their moist condition and the weight of the clay, the work should be set aside to become *leather-hard*; then building may be continued.



How to make a vase

Before continuing, however, the rim formed by the last coil should be cut squarely off with a knife and a thick mixture of slip applied with a bristle brush. A mucilage brush will answer the purpose.

When the vase has been entirely built it is

Pottery Made in School and Fired in Iron Covered Kettles in an Open Fire in the School Yard

allowed to dry out somewhat. Then it is scraped and carefully trued with a knife and finally with sandpaper.

DECORATING

The design is now scratched in by means of the sharp point of a wire nail, before the clay is thoroughly dry. The parts to be colored are brushed over with slip and the color is applied immediately. Pigment colors for application to the clay may be produced by reducing rotten stones of various colors to powder by means of a hammer, or better, by a *mortar and pestle*. Colors may also be procured at a paint or drug store. Yellow ocher is used for yellow-red, red oxide of iron for red, and black oxide of copper for black. The colors in powder form are mixed with liquid glue and are painted upon the slightly moist clay in the form of a thick paste. It is a good idea to scratch the surface with a pin or piece of broken window glass before painting the clay as this will improve the bond.

FIRING

In firing pottery it is not necessary to use a real kiln in order to do the work. Iron kettles placed in an open fire of wood will make it possible for us to fire our pottery by an open fire method similar to that employed long ago by the American Indians. The kettles will keep

the burning embers from falling upon and breaking the dishes. They should have iron covers. The heating and cooling should be gradual, the kettles being kept at a red heat for at least an hour.

Firing Pottery in the School Yard

If there is no clay at hand, it may be obtained from a school supply house. A low temperature clay should be specified when ordering.

In connection with the study of pottery it is suggested that the class collect magazine illustrations by which articles of pottery are advertised. These pictures can be mounted on large cards and the dishes illustrated should be compared. The

shapes should be judged from the standpoints of utility and beauty. Articles of pottery or fragments of pottery may also be collected to illustrate stoneware and chinaware.

KETTLES AFTER THE FIRE HAS DIED DOWN
The covers have been removed to show the fired ware

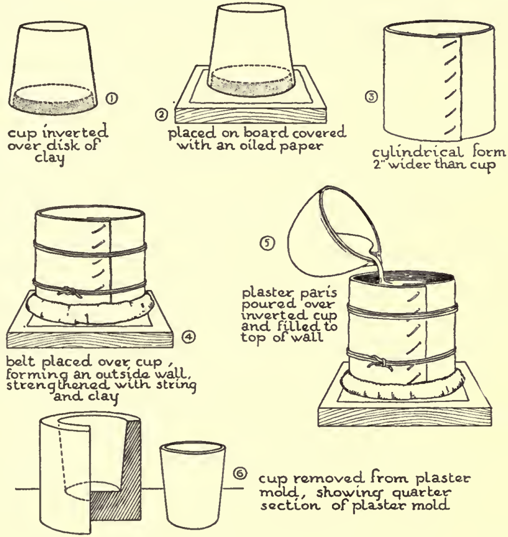
II

THE MAKING OF A PLASTER MOLD FOR SLIP POURING

We shall now learn how to make a plaster mold from a small bowl or cup. This is the method employed in industry for making a number of cups or vases, all just alike.

Bring a bowl or a small glass tumbler from home for the purpose of making the mold. Choose a small article without a handle or a projecting ring at the bottom. The processes involved in making a mold are as follows:

(1) Invert the tumbler over a disk of clay which is at least ¼ inch in thickness and equal in diameter to the diameter of the mouth of the tumbler.



Making a plaster mold for slip pouring

(See 1 in illustration.) This is placed upon a small piece of board which has been covered with a piece of stencil or oiled paper.

(2) Cut a piece of heavy, flexible, oiled paper into the form of a belt, at least 1 inch wider than the

height of the dish for which the mold is to be made, and long enough to encircle the tumbler, leaving at least 1 inch between the belt and the dish all the way round. Sew the two ends of the belt together with a piece of string. It will serve as an outside form wall, as shown in 3 of the picture.

(3) Strengthen this wall by winding string around it and by banking moist clay against it on the outside. (See 4 in illustration.)

(4) Prepare a size by dissolving a piece of soap, as large as a walnut, in one-half pint of water. The water may be heated to hasten the process. When cool the size should be of the consistency of syrup.

(5) A coat of size is now applied with a brush to the entire surface of the inverted tumbler. It is well to go over the tumbler twice to make sure that all parts have been covered.

(6) Plaster of Paris is now mixed in another dish for pouring. For every quart of water 2¾ pounds of plaster should be used. The plaster is put into the water, a handful at a time. When it has been allowed to soak for two minutes, the hand of the worker is put into the mixing dish and the plaster thoroughly stirred to the consistency of cream. The mixture is soon felt to thicken. When it has become as thick as batter it should be poured at once over the inverted tumbler, care being taken to cover all parts of its surface. Fill the form to the top of the wall

as shown in 5 of the illustration. Air bubbles must be broken or kept from being poured into the form.

(7) The work is now left for a few minutes, while attention is given to the mixing dish which must be rinsed at once before the plaster *sets*. The rinsing water should be carried out of doors; if poured into a sink, it will stop up the drain pipe.

(8) The process of hardening, called setting, began as soon as the liquid plaster was poured into the form. In about ten minutes from the time of pouring, the plaster will begin to *heat*. This warmth indicates the completion of setting.

(9) The paper belt is now removed and the sides of the plaster mold are trued with a knife. This is easily done as the walls are still quite soft.

(10) The plaster cast is next turned over and the tumbler removed.

(11) The mold is now put aside to dry. It is important that all the water dry out of the plaster form before it is used for casting.

III

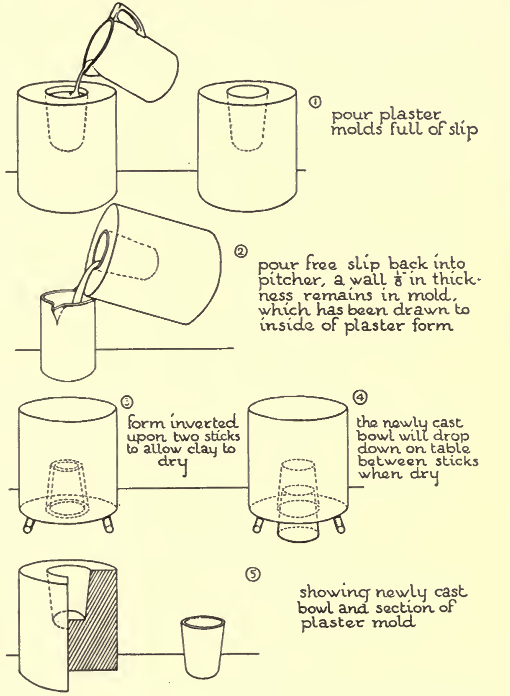
The Casting of a Small Bowl or Tumbler by Means of a Plaster Mold

Bowls are cast by pouring slip into plaster of Paris molds. It is convenient to make the slip in small quantities. Let us place in a dish of water, a lump of clay which has been thoroughly kneaded to a plastic condition. Warm water is preferable.

We shall mix this with the water by constantly squeezing the lump of clay at the bottom of the dish until it disappears. The mixture of clay and water will get thicker and thicker as additional particles of clay become suspended in the water until the consistency of batter is finally reached. The slip is now poured through a sieve into a large pail in order to remove any remaining small lumps of clay.

(1) The plaster molds which were made in the previous lessons are arranged in a row. Two pouring dishes are provided for the slip. Pitchers may be used or "tin" cans bent to facilitate pouring. Before using the slip, however, it should be slowly poured back and forth from one pitcher to the other in order to break any of the air bubbles which are likely to form in newly prepared slip.

Each plaster mold still retains some of the soap size which must be removed before the mold can be used. It is therefore cleansed by being filled with the slip, which is at once emptied out. It is then allowed to stand for ten minutes in order that the water may be absorbed from the clay which has been deposited upon the walls. This thin lining of clay is now picked out by means of a small piece of plastic clay, which is pressed against it. The thin clay coating will readily adhere to the piece of moist clay. If all of it cannot be taken out in this way it may be wiped out with a piece of cloth. After being cleaned



casting a small bowl by means of a plaster cast

the form should again be allowed to dry out thoroughly.

(2) Each of the plaster molds in turn is now poured brimful of slip, which is allowed to round over the opening in a little mound, which gradually sinks lower and lower into the form as water is absorbed into its plaster walls. After the last form has been filled it is likely that the first will be ready for refilling. The process of filling is continued, each of the forms being kept brimful. After all have been kept full for a couple of minutes, the blade of a knife is scraped across the brim of the first form in order to determine the thickness of the clay wall which has been drawn to the inside of the plaster form, this clay deposit forming the wall of the dish which is being cast. A thickness of one-eighth inch is desirable. If the walls have not attained this thickness the pouring must be resumed.

(3) The plaster form is next carefully lifted and the free slip poured out, as shown in 2 of the illustrations on page 135.

(4) Each form is now inverted upon two sticks or pencils to provide for circulation of the air under it. (See 3 in illustration.) A small quantity of slip will drip from the forms before the drying begins. The forms should be left inverted and undisturbed for at least an hour, at the end of which time the first may be examined for removal. If the drying has progressed far enough the clay wall will

be found to have shrunken slightly from the plaster. Often the newly cast clay dish will drop down on the table between the sticks or pencils. If the dish does not drop down of its own accord the form should be held brim down in the palm of the left hand while it is tapped sharply with the fingers of the right hand.

(5) The newly cast dishes are put aside to dry. After they have become quite dry they are finished with No. 00 sandpaper. They are then fired.

IV

The Making of a Square Dish or Jardinière for Flowers

Our jardinière will be elevated upon four feet, one at each corner. If a kiln is available, this piece should be glazed. The side of the flower dish will furnish a problem in design involving an application of the principle of balance. We shall determine the proportions first, after which we shall consider the placing and shape of legs, the decoration, and the color. The design will be incised by means of a sharp nail. The motif for the design may be suggested by natural forms such as flowers, fruit, birds, etc., or it may be geometric. Our design on paper should emphasize the shape and surface of the dish. We shall work with colored crayons, striving to represent correctly the colors of the clay and the minerals used in decorating. The color scheme will be *analagous;*

i.e., containing those colors lying next to one another in the color circuit, as blue and blue-green; blue-green and green; green and green-yellow, etc.

We shall make the sides and bottom separately (five pieces). These parts will be welded together by means of slip. The surfaces to be united are first covered with slip applied with a bristle brush. The surfaces are immediately united by being pressed firmly together and tapped with the finger tips to increase the bond.

The jardinière may be fired, either according to the open fire method or in the school kiln, if it is to be glazed.

Potter's Song

Turn, turn, my wheel! Turn round and round
Without a pause, without a sound;
  So spins the flying world away!
This clay, well mixed with marl and sand,
Follows the motion of my hand;
For some must follow, and some command,
  Though all are made of clay!

Turn, turn, my wheel! All things must change
To something new, to something strange;
  Nothing that is can pause or stay;
The moon will wax, the moon will wane,
The mist and cloud will turn to rain,
The rain to mist and cloud again,
  To-morrow be to-day.

Turn, turn, my wheel! All life is brief;
What now is bud will soon be leaf,
  What now is leaf will soon decay;

Nils Forsberg *Courtesy Toledo Museum of Art,* © *Detroit Publishing Company*

Potter of St. Amand

The wind blows east, the wind blows west;
The blue eggs in the robin's nest
Will soon have wings and beak and breast,
  And flutter and fly away.

Turn, turn, my wheel! This earthen jar
A touch can make, a touch can mar;
  And shall it to the Potter say,
What makest thou? Thou hast no hand?
As men, who think to understand
A world by their Creator planned,
  Who wiser is than they.

Turn, turn, my wheel! 'Tis nature's plan
The child should grow into the man,
  The man grow wrinkled, old, and gray;
In youth the heart exults and sings,
The pulses leap, the feet have wings;
In age the cricket chirps, and brings
  The harvest-home of day.

Turn, turn, my wheel! The human race,
Of every tongue, of every place,
  Caucasian, Coptic, or Malay,
All that inhabit this great earth,
Whatever be their rank or worth,
Are kindred and allied by birth,
  And made of the same clay.

Turn, turn, my wheel! What is begun
At daybreak must at dark be done,
  To-morrow will be another day;
To-morrow the hot furnace flame
Will search the heart and try the frame,
And stamp with honor or with shame
  These vessels made of clay.

Stop, stop, my wheel! Too soon, too soon
The noon will be the afternoon,
Too soon to-day be yesterday;
Behind us in our path we cast
The broken potsherds of the past,
And all are ground to dust at last,
And trodden into Clay!

From "Keramos" by Henry Wadsworth Longfellow

Exercises for Study and Review

(1) By what people was the first pottery made in America? What kind of pottery was it? How was it made?

(2) What kind of clay is used in making the finest grades of pottery?

(3) Is pottery a healthful occupation? Can it be made more healthful than it is?

(4) What are some of the qualities which good tableware should possess?

(5) How can you tell a good decoration on tableware when you see it?

(6) Explain Neils Forsberg's picture "Potter of Saint Amand."

(7) What shapes of ware are usually cast? Why?

(8) Why are saggers used in firing most kinds of pottery?

(9) Bernard Palissy was a potter who once produced some very beautiful glazes. Read the story in the book suggested at the end of this chapter or refer to his name in the encyclopedia.

(10) Where are the great pottery centers of the United States? Why do you think these locations were chosen?

(11) If you had an opportunity to work in a pottery what kind of work would you prefer to do?

Suggested Reading about Pottery

Barber.—*The Pottery and Porcelain of the United States.* G. P. Putnam's Sons.

Binns.—*The Potter's Craft.* D. Van Nostrand Company.

Bishop and Keller.—*Industry and Trade* (Index under *Clay Industry*). Ginn & Co.

Bush and Bush.—*Industrial and Applied Art Books,* V, VI, VII, VIII. Atkinson, Mentzer & Company.

Cox.—*Pottery for Artists, Craftsmen, and Teachers.* The Macmillan Company.

Holland.—*Historic Inventions* (See *Palissy and His Enamel*). George W. Jacobs & Co.

Longfellow.—*Complete Poems* (See *Keramos*). Houghton, Mifflin Company.

Moore.—*Wedgwood and His Imitators.* Frederick A. Stokes Company.

Pottier.—*Douris and the Painters of Greek Vases.* John Murray, London.

Snow and Froehlich.—*Industrial Arts Text Books,* V, VI, VII, VIII. The Prang Company.

Tarr and McMurry.—*New Geographies* (Index under *Delftware, Limoges, Porcelain Manufacture, Rookwood*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials.* Ginn & Co.

Wells.—*How the Present Came from the Past,* Book Two (Index under *Vessels, Dishes, Furnace, Glaze, Potters, Pottery, Vases*). The Macmillan Company.

Williams.—*How It Is Made* (Chapter VII, *Chinaware and Porcelain*). Thomas Nelson & Sons.

Walter S. Louderback

CEMENT AGE

VI

CEMENT AND CONCRETE

We hear a great deal more nowadays than formerly about concrete construction. A long list of things ranging from sidewalks and fence posts to great buildings, dams, bridges, barges, and even large ships are built of it, and yet its use as a constructive material is not new. The great Chinese wall was built largely from concrete and the Romans at the beginning of the Christian era made use of it almost as generally as we do today. The ancients, however, employed a ground natural cement, whereas we use a manufactured product.

The popularity of concrete as a building material is due to its cheapness, convenience, durability, strength, and fire-resisting qualities. For building purposes, it is superior to most varieties of stone both in strength and in durability while stone is, of course, far more expensive. Concrete is replacing timber in many of the industries, a fact which is due chiefly to the scarcity of timber.

Three materials are used in the making of concrete: (1) the *matrix*, or binding material, which is generally portland cement, so named by its originator, Joseph Aspdin (1824) of Leeds, England, because of its resemblance to the cliffs of Portland, England; (2) the *aggregate*, which

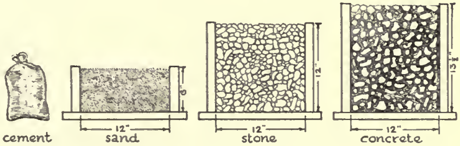
Courtesy of Pennsylvania Railroad

Concrete Bridge over Schuylkill River at Manayunk, Pennsylvania

consists of hard particles such as broken stone, gravel and sand; (3) *water*.

The principal ingredients of portland cement (the matrix) are limestone and clay. These are obtained from rocks which are mined or quarried as the conditions require. Marl or river mud sometimes furnishes the raw materials for portland cement. If rocks are used they are crushed in a powerful jaw crusher, and the crushed stone

pulverized in a *ball mill*, consisting of a barrel shaped container which turns on an axis. The process of grinding is accomplished by means of balls of steel which tumble and roll among the pieces of rock as the barrel revolves. Seldom if ever, are rocks found which contain all the constituents of portland cement; if lime is lacking in the cement rock, limestone is added to the



Quantities of cement, sand, and stone in concrete mixture, 1 part cement, 2 parts sand, 4 parts crushed stone or gravel, and the resulting quantity of concrete.

ground rock; if clay is lacking, it is furnished in the form of shale, etc.

When partially ground, the materials are properly proportioned; and they are then thoroughly mixed by being ground together. The resulting fine powder, known technically as the *raw mixture*, is fired in a *rotary cement kiln*, a great tube, cylindric in form, which is constructed of boiler iron and lined with fire brick. The kiln lies in a nearly horizontal position, being slightly elevated at the receiving end. The raw mixture enters

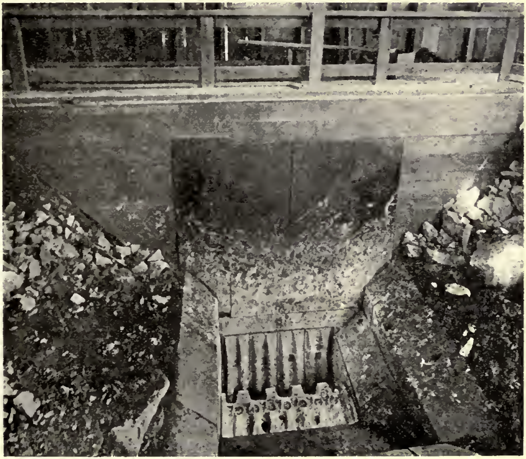
it at a hopper, which is attached to the elevated end, while the cylinder revolves just as a pencil revolves when twirled between the fingers. Cement kilns are from six to ten feet in diameter

Courtesy of New York and New England Cement & Lime Co.

Steam Shovel in Operation in Limestone Quarry

and from sixty to two hundred feet in length. They are revolved by means of huge *gears* which, extending entirely around the kiln, mesh with small driving gear wheels, while the tube rests upon riding wheels resembling large casters. An intense heat of from two thousand five hundred

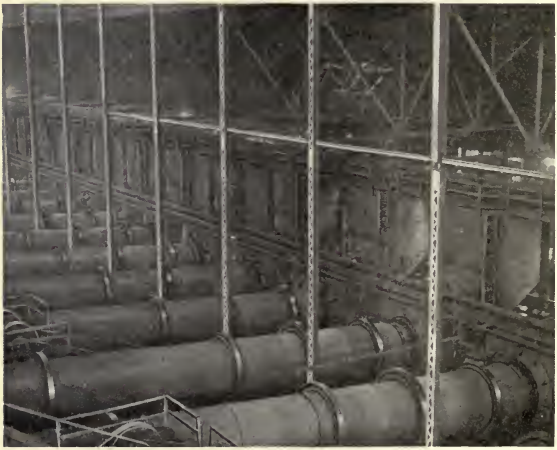
to three thousand degrees Fahrenheit is maintained in the kiln by the burning of powdered coal which is blown into it at the lower, or discharging end, by a forced draft. As the small particles of raw material gradually roll down



Courtesy of New York and New England Cement & Lime Co.
Crusher Used in Breaking Cement Rock

through the revolving tube of the kiln, they are burned, or *calcined* as the cement maker puts it, to *clinker*, and are dropped out at the lower end. The clinker comes out in the form of little balls which are about three-eighths of an inch in diameter Their surfaces are rough but they are quite round and uniform in size.

The clinker is now stored outside for from ten days to two weeks. It is then ground to powder once more in a ball mill. This time it is ground so fine that the powder will pass through a screen with forty thousand holes or meshes to



Courtesy of New York and New England Cement & Lime Co.

Cement Kilns

the square inch. This finely ground powder is our finished portland cement of commerce. In its production there have been five steps as follows: quarrying of raw material, grinding and mixing of the raw material, burning of this material to clinker, the storage of the clinker,

and the grinding of the clinker to portland cement.

When the first portland cement was made in England along the banks of the river Thames, it was fired in a *stationary kiln* The making of a

Ball Mills, Which Grind the Clinker into Portland Cement

single batch of cement then required about twenty-four days. To-day many hundreds of barrels are turned out by cement manufacturing companies every twenty-four hours.

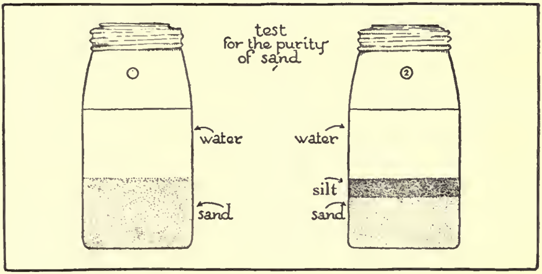
The aggregate used in the making of concrete consists of large stones and sand. All stones

Courtesy of New York and New England Cement & Lime Co.

Packing House Showing Storage Bins and Bags of the Finished Cement

which will pass through a sieve with four meshes to the inch are considered sand. The materials must be clean and hard. Sand which is too fine or which contains over five per cent of vegetable matter or silt will not produce good concrete. It should not be used.

In order to test the sand and to determine



if it is clean enough for use one may take a common one-quart *glass* fruit jar and place in it four inches of the sand to be tested. Water is poured in until it reaches to within three inches of the mouth of the jar. The jar is now covered and shaken vigorously until the sand is entirely suspended in the water. The mixture is allowed to settle until the water has cleared. If, after the water has cleared, the layer of silt which has been deposited above the sand is one-half inch thick the sand is not fit to use.

Sand containing dirt may be washed through a screen and the dirt separated from the sand.


Sand Filling Voids between Large Stone (poor)


Sand and Small Stone Mixed with Large Stone (better)

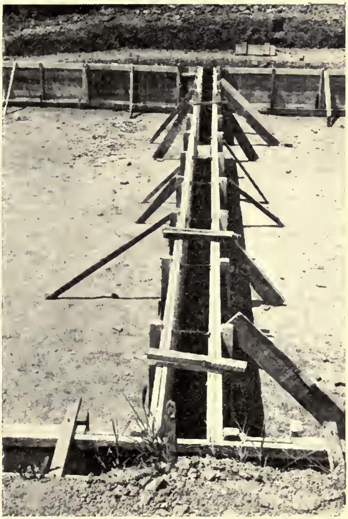

Mixture of Graded Stone and Sand (best)

The best results in concrete work will be obtained when various sizes of sand and stone are used. The small stones will then fit into and fill the *voids* or hollow spaces formed between the larger stones and a compact or dense mass will be produced.

Water that is fit to drink is best for concrete. Moderately warm water will hasten the hardening while extremely cold water will retard it. The hardening of concrete is called *setting*. It is a chemical process.

Concrete is *molded*, when soft, into appropriate shapes by the use of *forms* which must be made tight enough at their joints to prevent the mixture from running out, as it is poured into them

in a half liquid state. The forms should be adequately braced and tied to prevent the pressure of the materials from spreading them. Nearly all forms are made from wood, although iron and steel are coming to be used in the making of forms which are to be used over and over again. In the building of foundations, trenches are dug and the walls of earth thus formed are often utilized as the molding forms below the ground. In the making of concrete pottery, small articles, and statuary, plaster of Paris forms are sometimes used.



Courtesy of Portland Cement Association

Forms for a Concrete Foundation Wall

Concrete structures are often *reinforced* in order to strengthen them; especially is this done where they must stand tensile (pull) strain. The kind of reinforcing and its placing depends upon the shape of the structure and the location

Courtesv Joseph Dixon Crucible Co.

An Irrigation Dam Built of Concrete

The Roosevelt Dam in Salt River, near Phœnix, Arizona, is one of the most impressive irrigation structures in the world. From foundation rock to top of parapet walls, it is 284 feet high, its length on crest is 1080 feet, and its cubical contents 326,000 yards. Its base covers approximately an acre of ground. The first stone was laid in 1896, and the structure was finally completed in 1911. The dam serves a dual purpose; first, it conserves floods and, second, it develops power. The storage reservoir thus created is one of the largest artificial bodies of water in the world. Spread out a foot deep the water held back by the dam would more than cover the state of Delaware.

of its weakest parts. Small structures are reinforced by the imbedding of iron or steel wires in them while the concrete is being poured. For heavier work, coarse iron bars and even steel girders are used.

Concrete must be *mixed* thoroughly. The

Courtesy of Portland Cement Association

Mixing Concrete by Hand

purpose of mixing is to get the finer aggregate to fill the little voids between the bits of coarser aggregate in order that a dense mass may be produced, and to provide that each particle of aggregate shall be entirely coated over with a thin covering of cement which will cause it to adhere to those about it. Each tiny grain of cement must be thoroughly wet if an efficient hardening is to be obtained, a setting which will bind the whole mass

together into a compact, stone-like conglomerate. The setting of concrete is not a drying process—quite the reverse. Drying must be prevented until setting is thoroughly accomplished.

When concrete is to be mixed by hand, a large

Courtesy of Portland Cement Association

Mixing Concrete in a Rotary Batch Mixer

mixing platform built of planks is used. The platform is constructed with strips nailed to its edges to keep the liquid mixture from running off. The fine aggregate and the cement are first mixed dry and then water is added slowly while the mixing is continued. The coarse aggregate is then wetted and is mixed with the finer materials.

When concrete is not mixed by hand the mixing is usually accomplished by means of a *rotary batch mixer*, a power-driven machine which whirls a barrel into which the materials are poured by means of a hopper. They are first mixed dry and then the water is turned in. The barrel is revolved until all the materials are thoroughly combined. The following are some of the standard concrete mixtures:* Rich mixture, 1:2:3, used in water tight tanks and in structures which must be very strong; standard mixture, 1:2:4, used in machinery foundations and in floors; medium mixture, 1:2½:3, used in retaining walls, sidewalks,** and similar structures; lean mixture, 1:3:6, used in heavy walls and in large work generally. Newly poured concrete should be protected in winter against freezing, and in summer against evaporation or drying out of the water.

Just what takes place when concrete sets is not definitely known, but we do know that the bond continues to strengthen for a long time after the concrete has had its initial or first hardening. It will stand a much heavier load after it is a year old than when only a month old.

*The first figure indicates the number of parts of cement; the second, the number of parts of fine aggregate; the third, the number of parts of coarse aggregate.

**Sidewalks are often made with a 1:1½:5, mixture as a base and finished with a 1:2, mixture (1 part of cement and 2 parts of sand).

How long this gain in strength continues, is yet to be determined by the scientist.

Lorado Taft's statue of Black Hawk, shown in the illustration on page 159, is one of the most remarkable concrete structures in the world. This commanding figure of an Indian Chief stands on a high bluff overlooking the valley of the Rock River in Illinois, former haunt of red men. Mr. Taft was inspired to create this colossal statue by the desire to erect a memorial which should commemorate a race fast vanishing from the country which it once owned and occupied.

Courtesy of Portland Cement Association

Making a Concrete Sidewalk

Charles De Garmo has written the following in his poem *On the Colossal Statue of Black Hawk*. The poem will help us to appreciate the impressiveness and beauty of the statue.

These fertile farms that broaden on the sight,
Where now the households pass their busy hours,
Were once wide plains bedecked with prairie flowers,

Photograph by C. R. Childs

Lorado Taft's Statue "Black Hawk," at Eagle's Nest Bluff on Rock River, Oregon, Illinois

Or swept by autumn fires that lit the night.
Thou stand'st for him who taught his martial band
In camp, in ambush, and in battle's rage,
To hold their hunting-grounds with heavy hand
'Gainst swarming foes who sought their heritage.

The statue is of solid concrete except for a vertical shaft which permits the visitor to be elevated to the figure's folded arms. Here he can look out over the meadows, river, and wooded landscape without being observed from below. The height of the figure is fifty feet and its weight two hundred and seventy tons.

In planning for this great memorial, Mr. Taft first made a six foot preliminary plaster model. Then the site for the monument was chosen and a foundation and elevator shaft built. Careful measurements were taken from the preliminary model and transferred to a framework of scantlings built up around the elevator shaft. In this way the projecting points on the surface of the large figure were fixed as by a skeleton. But it must be remembered that in this instance the skeleton was outside of the figure rather than within. The elevator shaft only was to remain within.

The points of the skeleton were connected by stretching wire netting over the timbers. Burlap was nailed over this and plaster of Paris was finally spread inside the burlap covering to make it

*De Garmo.—*Aesthetic Education.* C. W. Bardeen.

stiffer. Then a covering of plaster of Paris three inches in thickness was built up outside of this. When all the braces and timbers had been removed

Form Partly Removed from the Face of the Taft Statue of Black Hawk

from the inside of the hollow figure, concrete was poured into the form and around the elevator shaft until the entire figure was cast. Then the outside form was removed.

It took two summers to erect the statue. Five hundred barrels of portland cement were

used. The concrete was taken up in the center in an elevator operated by a motor and windlass.

Removing the Form from the Body of the Taft Statue of Black Hawk

I

The Making of a Small Concrete Box

In the making of a rectangular box from cement mortar,* similar to those shown on page 163, the following steps are observed:

(1) Determine the use for the box and its

* Because of the small size of the box, coarse aggregate is not used. The mixture is, technically speaking, mortar rather than concrete.

dimensions. No dimension shall exceed 5 inches. The walls and bottom will be 1 inch thick.*

(2) Make a working drawing of the box, representing three views. (See page 164.)

(3) When the box is cast in concrete it will be necessary to use a clay *core* to provide for the shape of the inside of the box. Make a

FINISHED BOXES WITH COVERS
These boxes have walls but one-fourth inch thick.

working drawing of this core, using the inside dimensions of the box as dimensions for the core. (See page 165.)

(4) Compute in cubic inches the total volume of the box, solid.

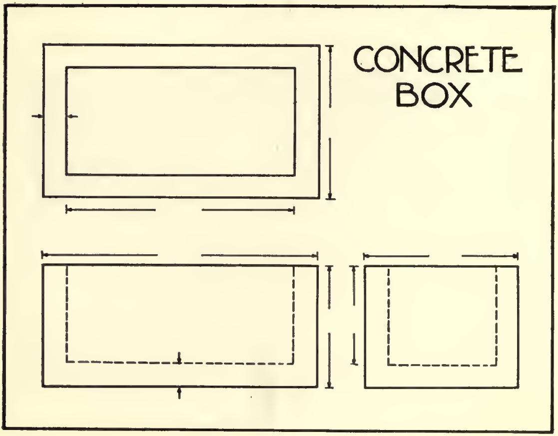
(5) Compute the volume of the core.

(6) Find the difference between these two

* The walls shown in the illustrations are all $\frac{1}{4}$ in. thick rather than 1 in. as given in the directions. The dimensions are given in the text as 1 in. in order to simplify the construction.

quantities, which will give the cubic content of the walls and bottom of the box.

(7) Allowing ½ of this volume for loss when the materials are mixed (the cement filling the



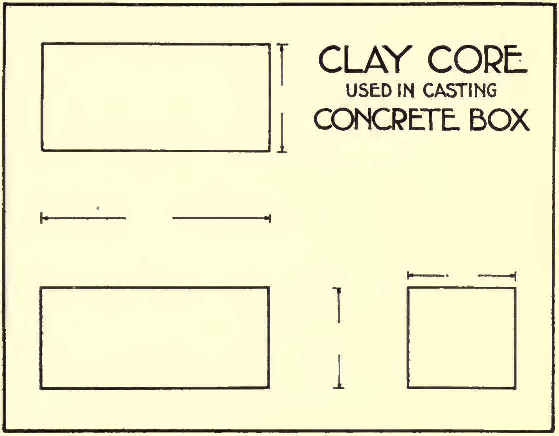
voids between the grains of sand), determine the number of cubic inches of material needed.

(8) 4 parts of cement will be used to 2 parts of sand.* How much cement will be used? How much sand?

* White portland cement and marble dust may be substituted for these materials if the marble dust can be obtained from the dealer. Boxes made with the marble are more attractive than those made with sand.

(9) Make core of moist clay or of modeling wax.

(10) The box will be cast in an inverted position with the mouth down. Place the core on a piece of board, putting a sheet of paper (waxed or stencil paper is best), under the clay to



prevent the concrete from sticking and the wooden board from warping.

(11) Prepare the outer walls of the form, building them of clay or modeling wax about one inch in thickness, leaving a full one inch between the core and the walls, carrying the walls up a little over 1 inch above the top of the core in

order to provide for the bottom of the box. (See illustration.)

(12) Construct a measure in the form of a 1 inch paper cube, for cubic measure. Use heavy paper and provide laps for gluing.

Building Outside Form Walls

(13) Measure out the cement and sand, placing these materials in a shallow dish. (A pie tin makes a good mixing pan.)

(14) Mix the materials dry, and then slowly add water while mixing until the mixture is just thin enough to pour. A broad knife (putty knife or a spatula) is a good tool for mixing.

(15) Strengthen the clay form by piling clay about it on the outside and by winding and tying a string around the form.

(16) Pour the concrete mixture into the form,

Pouring Cement Mortar into the Clay Form

over the core, being careful to avoid air bubbles. (See illustration.)

(17) *Tamp* with knife, being careful not to disturb the core.

(18) Place long wire nails across the core in order to reinforce the box at the bottom. Do not allow the nails to project to within more than ¼ inch of the form walls.

(19) Put away to set. The cement will begin to harden within half an hour. Damp cloths should be thrown over the form at the end of an hour from the time of pouring; this will prevent the evaporation of the water and will thus facili-

Removing the Clay Form

tate setting. The form should not be disturbed until at least two days have elapsed.

(20) Carefully remove outside clay form (See illustration), and dig out the clay core.

(21) Smooth the outside of the concrete box by rubbing it over a piece of No. 3 sandpaper spread flat on the table, being careful not to break the box as it is still quite soft.

(22) Make on paper, using pencil, a simple

border design in line, adapting it to the purpose of decoration.

(23) Scratch this design upon the box with a sharp wire nail.

(24) Place the completed box in a pail of water to become as hard as a rock. The more time allowed for this process, the better. Four days, however, will be found sufficient.

(25) Remove the box from the water.

(26) Drain the water out of it and allow all moisture to dry out of the walls and bottom.

(27) Paint the box, if desired, with Toch's cement filler or with any other suitable varnish for concrete structures. If a dull finish is desired, the hard varnish may be sanded with No. 00 sandpaper.

The following is given as an example of the computation of materials:

Dimensions of box, 5 in. x 4 in. x 3 in.

Dimensions of core, 3 in. x 2 in. x 2 in.

(1) Volume of box (solid) = 5 x 4 x 3 x 1 cu. in. = 60 cu. in.

(2) Volume of core = 3 x 2 x 2 x 1 cu. in. = 12 cu. in.

(3) Number of cu. in. in the walls and bottom = 60 cu. in. − 12 cu. in. = 48 cu. in.

(4) Amount to add for loss when mixing = ½ x 48 cu. in. = 24 cu. in.

(5) Total amount (by volume) of materials needed = 48 cu. in. + 24 cu. in. = 72 cu. in.

(6) A mixture of 4:2 (6 parts) will be used.

(7) Amount of cement necessary = 4/6 x 72 cu. in. or 48 cu. in.

(8) Amount of sand necessary = 2/6 x 72 cu. in. or 24 cu. in.

It will be noticed that the boxes shown on page 163 have covers. These were made according to the following method. After the box had been cast, the clay core was again placed in it. This core however did not extend quite to the brim of the box but was allowed to reach only to within 1/8 inch of the brim. The box was then placed, brim up, on the table with the core in it. Oiled paper was wrapped tightly around the box on the outside and creased at the corners. String was wound around this oiled paper as it was wound around the clay form before. The brim of the box was covered with a thin layer of clay, and clearance for the removal of the cover was allowed on the inside of the box by making the clay covering thicker as it approached the core. A mixture of cement and sand was poured into the box, being allowed to extend up into the waxed paper form to the desired thickness of the cover. The newly poured cement mortar was then allowed several days to set. The cover was removed by carefully tapping the blade of a knife between it and the box. (The edge of the knife must extend the entire length of the box and the cover must be quite hard before this

is attempted.) Box and cover must be placed under water for the final hardening. If oiled paper is not available the making of a cover may be accomplished by the use of an outside form of clay.

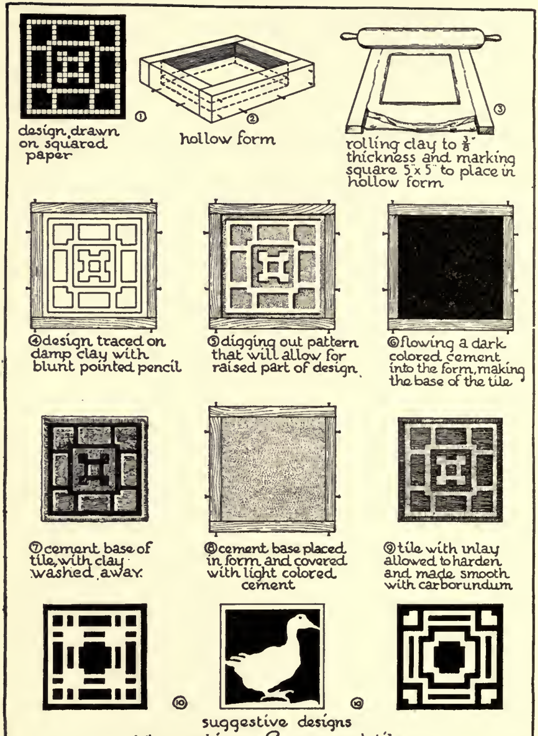
II

The Making of a Cement Mortar Tile

Eight steps in the making of the tile are shown on page 172. It may not be convenient to make this tile in the classroom. The description will be interesting even if the directions are followed only in the imagination of the reader.

A design is first drawn in pencil on a piece of squared paper, in this case 5 in. x 5 in. as shown in 1 on page 172.

The form (Page 172, 2) is a shallow square box. Five pieces of ⅞ inch *stock*, soft wood, are required in the making of it. White pine is recommended for work of this kind. One piece ⅞ in. x 5 in. x 5 in. is needed for the bottom of the form; two pieces ⅞ in. x 2 in. x 5 in., for two sides; and two ⅞ in. x 2 in. x 6¾ in. for the other two sides. As soon as the pieces are cut to size and squared, they are oiled with linseed oil that they may the better withstand moisture. The form may be assembled with nails or with nails and screws. All nails are driven to within about ⅛ inch of their heads that they may be drawn out easily after the cement has set. When both screws and nails are used, the screws will be



The making of a cement tile

placed in the side grain of the wood, the nails in the end grain.

With this box-like form, a flat tile 5 in. x 5 in. x 1⅛ in. could be cast. But if a decorated tile is desired, provision must be made in the form for the decoration. This might be worked out by carving the bottom of the wooden form. This process would not only be too difficult, but would also require a great deal of time. It is easier to use a layer of clay in the bottom of the form, as damp clay can be readily carved or molded. The clay is prepared in a sheet ⅜ of an inch in thickness, thus reducing the thickness of the layer, which it is possible to pour into the form from 1⅛ inches to ¾ of an inch, or, expressed arithmetically, 1⅛ in. – ⅜ in. = ¾ in. The ⅜ inch slab of clay may be made easily and quickly by the use of a rolling pin. Two ⅜ inch strips about 1 inch wide are nailed to a board. These are placed parallel to each other and about 6 inches apart. A damp cloth is spread over the board and strips. A ball of clay is placed upon the damp cloth and is first pressed with the hands and then rolled to the required thickness, the ⅜ inch strips acting as guides. When rolling the clay a damp cloth is placed between the clay and the rolling pin to prevent the clay from sticking to the rolling pin (Page 172, 3.) When the slab of clay is ready, a 5 inch square is marked upon it by inverting the wooden form and impressing the form into

the clay. The clay square is then cut out with a knife and placed in the bottom of the form. The 5 inch paper square upon which the design is drawn, having been cut from the squared paper, is now placed in the form upon the sheet of damp clay. A pencil with a blunt point is used to trace the design which is impressed into the clay as shown in 4 on page 172.

Teacher's Note: If this problem is to be introduced into a grade which has not used the ordinary woodworking tools, the forms may be made by an advanced grade for the lower grade, or they may be made by the school carpenter. Of course, it is best wherever possible to have the forms made by those who will later use them.

Little canals or ditches are now dug into the soft damp clay that the decoration may be produced by the flowing of cement into these. Digging is easily accomplished with a wooden stick whittled at one end to a wedge shape. A piece of 1/4 inch dowel rod about 5 inches long makes an excellent tool for the purpose. Before beginning to dig, one must decide just where to remove the clay and where not to remove it. The first time cement is to be poured into the form, the tile proper is to be cast. The second time, the cement is poured over the tile proper and the depressions are filled, the inlay being formed. This must be considered before the first pouring. Then, too, a little wall all the way around the tile must be provided for in the making of the clay mold. To provide for such a wall the line around the outside of the design

must be dug out in the clay sheet. As soon as this has been done there will be no further difficulty in deciding which parts should be dug out and which left. The ditches are dug to a depth of ¼ inch and are kept as true as possible at the bottom because the top of the finished tile is cast in the bottom of the form (Page 172, 5). The depth of these ditches will add ¼ inch to the thickness of the tile, making it 1 inch in thickness when finished.

If the form is not to be used at once it is put away with a damp cloth over it that the clay may not dry out or shrink. If this were not done the clay would shrink and would no longer fit the wooden form. If the water were allowed to dry out, the clay would no longer be fit to use to cast cement on because it would absorb water from the cement and prevent the mixture from setting.

A color scheme is now chosen, the black spots of the design representing a dark color, the white spots a light color. All will agree that the dark color looks best upon the outside of the design to hold it together. If the outside of the design is to be dark, it follows that the dark color is the one to be poured first. A great variety of colors can be produced by using ordinary dry painter's colors, which may be obtained from any paint or hardware store. Lamp black, ultramarine blue, yellow ochre, burnt umber, and red oxide

of iron are all good colors. They should be mixed with the dry cement first. This mixture is then moistened with water. Two or more colors may be mixed together to produce new colors. Lamp black will serve to gray the colors. Too much color in proportion to the amount of cement used should be avoided if the tile is to become hard. Beautiful color combinations are sometimes chosen from Japanese prints, or from magazine illustrations which are good in color. The color schemes may be made to match those used in the colored pictures. The dry mixture of color and cement should be used in matching the colors.*

In order to increase the strength of the tile it is well to reinforce it with wire screen of 1/4 inch mesh. If this screen cannot be obtained, ordinary wire fly screen may be used. After the first pouring of cement into the form a square piece of screen 4 3/4 inches x 4 3/4 inches is placed upon the soft cement and is worked down into it until it is about 1/4 inch below the surface. Care must be taken that this sheet of screen is equally distant from the four sides of the form, in order that 1/8 inch may be allowed all the way round for the final grinding of the edges. A tile reinforced in this way should be many times as strong as one in which no reinforcing has been used.

*Tiles of but a single color may of course be produced by the same process of casting. This would make the problem much simpler.

The first batch of colored cement (the darker color) about as stiff as a thin batter, is poured slowly into the form and flows down into the little ditches. Care must be taken to break all air bubbles which appear in the colored cement. The form after being poured full of cement is shown in 6, page 172. It is now covered with a wet cloth to prevent its drying out. The cloth is kept wet and the work is allowed to remain undisturbed for perhaps three days. The cement is fairly hard at the end of twelve hours but it is best to give it at least three days to harden. With a claw hammer the nails of the form are removed and, if necessary, the screws are taken out; sometimes the tile and clay will slide out after the two nailed pieces are removed. Care must be taken that the pressure from the hammer is so applied as not to chip or crack the tile. This may be avoided by prying against the bottom board of the form. After the tile with the clay clinging to it is taken from the form, the clay is removed from the tile by breaking off some of it from between the cement ridges with the wooden tool previously mentioned. The tile is now washed clean with a stiff brush and appears as shown in 7, page 172. The tile is next placed in water where it is allowed to remain for several days, six or seven being none too long if this length of time can be allowed. Of course the reason for leaving the tile in water is that the cement may continue to grow hard

until all chemical action has ceased. The action will cease as soon as the water dries out.

The tile is now taken out of the bath and the superfluous water brushed off. It is replaced in the wooden form while it is still wet, this time with the decorated side up. Cement of the second color to be applied, is mixed and poured over the tile, filling all the little ditches (Page 172, 8). Care must be taken not to pour any more cement than is needed, because all superfluous material will have to be ground off later. The tile is now treated in the same manner as before, although less time may be allowed for the setting.

After tile and inlay are both thoroughly hard, the tile is ground smooth with a coarse carborundum or other abrasive stone. It is placed flat upon a board and is ground smooth by rotating the stone. Both stone and cement are kept wet, the tile being washed frequently with a bristle brush that the progress of the grinding may be observed. As soon as all lines of the design have come clear the grinding is discontinued. Page 172, 9, shows the finished tile. The edges are ground square by placing the abrasive stone upon the board and against the edge of the tile.

Song of the Turbine Wheel

Hearken the bluster and brag of the mill!
The heart of the mill am I,
Doomed to toil in the dark until

The springs of the world run dry;
With never a ray of sun to cheer
And never a star for lamp!
It cries its song in the great World's ear,
I toil in the dark and damp.

And ever the storm clouds cast their showers
And the brook laughs loud in the sun,
To goad me on through the dizzy hours
That the will of the mill be done!
And that is why I groan at work;
For deep down under the flood I lurk
Where the icy midnight lingers;
While *tinkle, tinkle* the waters play,
To the tune of a hundred sacks a day,
All with their crystal fingers.

Oh, the waters have such a rollicking way
And they taunt me in my pain;
" 'Tis thou alone art sad," they say,
"Thy rusty whine is vain;
For the grass is green and the skies are blue
And a fisherman whistled, as we came through,
A careless merry tune;
And a bevy of boys were out with their noise
In our flood made warm with June!"

And bound as I am where the darkness lingers,
I half forgive their careless way,
Such soothing, tinkling tunes they play—
All with their icy fingers.

JOHN G. NEIHARDT

From "The Quest"; The Macmillan Company.

Exercises for Study and Review

(1) Name some familiar constructions which are made from concrete.

(2) What three things are always used in making concrete?

(3) How are you able to distinguish sand from gravel?

(4) How is portland cement made?

(5) Which do you prefer as a building material, brick, tile, wood, or concrete? Why?

(6) For what kinds of work is concrete preferred?

(7) Why are the cement and sand first mixed dry in the making of concrete?

(8) What is meant by reinforced concrete?

(9) Why do you think Lorado Taft used concrete in making his statue of the Indian Chief, Black Hawk?

(10) Why does a mason need to be strong physically?

(11) What proportions of material are used in making concrete for a sidewalk?

Suggested Reading about Portland Cement and Concrete

Bishop and Keller.—*Industry and Trade* (Index under *Portland Cement*). Ginn & Co.

Bush and Bush.—*Industrial and Applied Art Books*, VII. Atkinson, Mentzer & Co.

Chamberlain.—*How We Are Sheltered* (Page 139, *Artificial stone*). The Macmillan Company.

Davison.—*Concrete Pottery and Garden Furniture.* Munn & Co.

Husband.—*America at Work* (Chapter on *Concrete*). G. H. Ellis Co.

Portland Cement Association.—*Concrete in the Country.* Portland Cement Association.

Rodgers and Others.—*Trade Foundations* (Index under *Concrete, Concrete Construction*). G. M. Jones, Indianapolis.

Tarr and McMurry.—*New Geographies*, Second Book (Index under *Portland Cement*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials*. Ginn & Co.

Vesper L. George

VII

THE TEXTILE INDUSTRIES

When man first began to think of interlacing strands to form a mat, he also thought of using various smaller fibers, rudely twisted together, in place of large strands. To him it was plain that a rope of twisted fibers has many advantages over a single fiber of the same thickness. As many fibers were too short to be woven, there was an obvious advantage in using many small fibers twisted together to make a single strand.

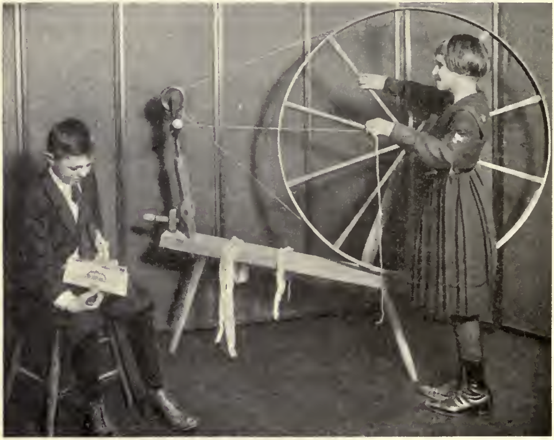
In primitive times, the fibers used in making strands were straightened out or *carded* by hand, with two small boards from which spikes projected, and were spun by pulling them out and twisting them between the fingers. As it was difficult to

Carl Marr *Courtesy of the Metropolitan Museum of Art*

GOSSIP

handle a mass of the carded fibers without disarranging them, it was customary to wrap them lightly about a stick called a *distaff*, and to prevent unwinding by tying.

The process of spinning fibers with the fingers was very laborious. The spinner would fasten



Carding and Spinning Wool Fiber in School

the distaff in her belt or hold it under her arm and, drawing out a few fibers at a time, she would twist them slightly and fasten them in a cut or cleft in the end of a wooden *spindle*. Then giving the spindle a twirl, she would keep pulling out fibers, while the weight of the whirling spindle would stretch and twist the fibers into a smooth,

even thread. When the spindle slackened its whirling and stopped, it would, if left alone, reverse its motion and untwist the thread. To prevent this, the spinner either gave it an additional twirl in the proper direction, or, if the thread was long enough, wound it around the

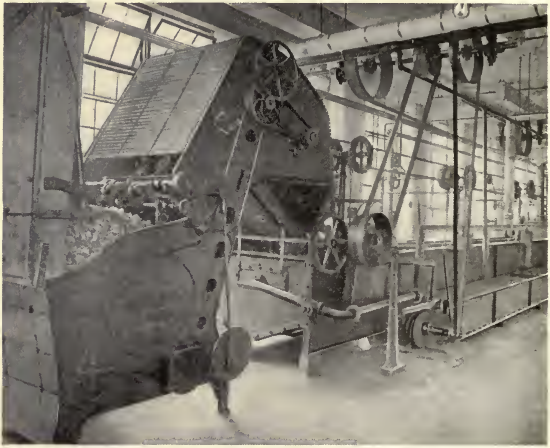
© *American Woolen Co.*

Sorting Fine Australian Wool

spindle and again fastened the string in the cleft end.

The next change in spinning was brought about by the introduction of the *great wheel.* This consisted of a large wooden wheel which was attached by a belt to a little wheel and spindle. The large wheel was whirled by hand

or by means of a foot treadle. The operator of the great wheel fastened her distaff of carded fibers in her belt and, pulling out a few of the fibers at a time, she twisted them and fastened them in the cleft end of the spindle. Then causing



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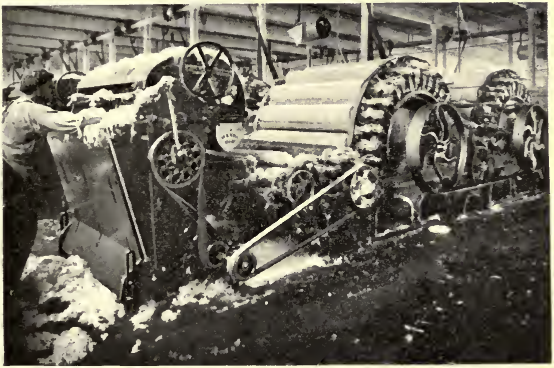
Wool Scouring. Removing the Dirt and Grease

the large wheel to revolve, she fed out fibers and pulled her hand away at a slight angle from the revolving spindle and nearly in the direction in which the spindle pointed. When the thread or *yarn* was twisted sufficiently, she stopped the machine. Then in order to keep the spun thread from snarling and untwisting, she wound it on

the spindle. To do this she moved her hand around until the thread was at a right angle with the spindle; and, slowly turning the wheel, she guided the thread along the turning spindle and wound it. Then she tucked the end of the spun thread back into the cleft end of the spindle, and, feeding more fibers, continued the process



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Carding Wool by Machine

of spinning and winding until the spindle was full of spun yarn. Then she would usually wind the yarn off by means of a reeling device into a bundle, called a *skein*. Sometimes the yarn was wound on a *shuttle* for weaving.

For many years people continued to use such primitive methods of making yarn. About the middle of the eighteenth century however many

changes were introduced in textile manufacturing. New machines completely revolutionized carding and spinning. The invention of the steam engine made it possible to operate the machines at a greater speed. Indeed had the steam engine not been invented it is not

Courtesy of Cheney Brothers *© Keystone View Company*

Reeling Raw Silk from Cocoons, Japan

likely that spinning machinery would have been improved as it was.

Fibers have to be prepared before they are carded; for example, cotton must be ginned and cleaned, and wool must be scoured and oiled. Materials from various bales or bundles are often thoroughly mixed or *blended* by being fed at

the same time into a machine. Sometimes gray and white fibers are blended to make gray cloth.

Carding is done by machine by means of a slowly revolving cylinder and several swiftly

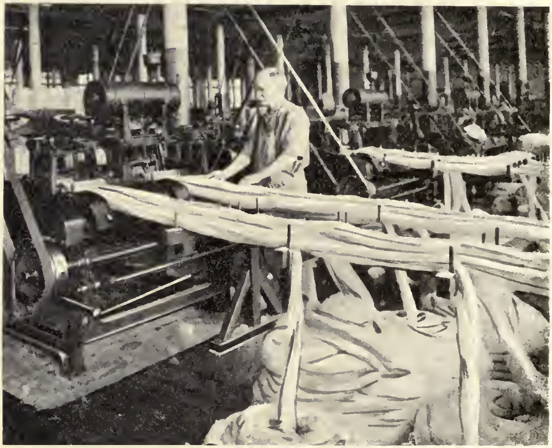
Courtesy of Cheney Brothers © *Keystone View Company*

Rereeling Raw Silk in Japan

turning smaller cylinders arranged about it and revolving in the opposite direction. Each cylinder is covered with fine, wire spikes. The fibers are passed between the spikes of the large cylinder and those of the smaller cylinders (see page 187).

Because of the invention of carding machines,

which greatly lessened the work of preparing fibers, and on account of many inventions in the weaving industry, there came to be a great demand for spun yarn to keep the new weaving machines in operation. It was necessary that some one



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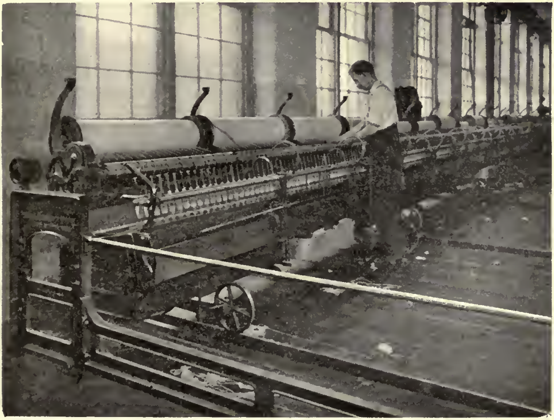
Gilling Wool into Parallel Filaments after Carding

should invent a machine for spinning several strands at one time. This invention was accomplished in England where, in 1738, two partners, John Wyatt and Lewis Paul, contrived a spinning device which used *drawing rolls* to pull out the yarn, and a *flyer* for twisting the fibers into a thread. About 1765, John Hargreaves

took out a patent for the *spinning jenny*, a machine run by hand which was worked much like the great wheel. It could spin about a dozen threads at a time, but they were of a quality which could only be used for the *weft* or filling threads in weaving.



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Spinning Wool Fiber by Machine

About three years after this invention, Richard Arkwright, another Englishman, took out a patent for a *water frame* or drawing frame. It had a continuous motion and caused the fibers to be drawn out by two sets of rolls, running at different speeds. Very fine threads could be spun on the water frame.

Indian Woman Weaving a Blanket on a Primitive Loom

The Warp Threads are held in a vertical position, the loom frame being suspended in the open air.

The best parts of these two machines were united in 1779 by Samuel Crompton, of Bolton. England, in the *mule spinning frame*. This machine proved to be capable of making good yarn, which could be used for weft threads and for warp or lengthwise threads alike.

Finally the triumph of skill in spinning was realized in the invention of the modern self-acting mule, in 1830. When this invention was perfected, spinning caught up with carding and weaving, and the output of the three industries was again balanced.

WEAVING IN SCHOOL
Passing the Shuttle through the Shed

Weaving is the art of interlacing threads to form a web. The threads which extend lengthwise of the woven fabric are called *warp*, while those that fill the fabric, by crossing the warp threads, are called the *weft* or filling threads.

The *loom* is a machine for the weaving of various fabrics. It must perform three different movements: (1) It must separate the warp threads to form a *shed*, some threads being raised while others are being depressed; (2) The weft

thread must be passed through the shed thus formed by the warp threads; (3) The weft thread must be pushed tightly against the growing woven fabric. Weaving consists in carrying on these three operations in the order named.

The alternate warp threads are raised and lowered by means of a *harness frame*. In the earliest devices used for weaving there was no harness frame and the weaver had to perform a separate operation or set of movements, as in sewing or darning, for every warp thread. By the use of a harness frame, warp threads that are to pass above the weft thread are separated from those that are to pass below it, and the shed is formed which enables the weaver to pass the weft thread entirely across at a single movement.

Looms were formerly operated only by hand, but, on account of the increase in the cost of labor, power looms have replaced the hand looms.

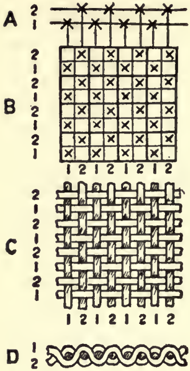
Weaving was one of the first of the industrial arts to be taken up by primitive people. The Chinese, Hindus, and Egyptians became very proficient in it. The people of the United States learned to weave from the mother country, England.

When our land was discovered, the American Indians were found using crude looms. The warp threads were often rolled up on one stick, while the finished cloth was rolled on another. The Indians sometimes held their work vertically,

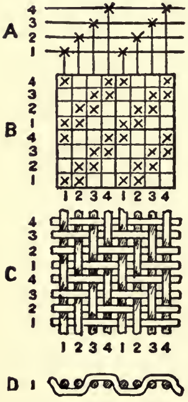
fastening one end of the warp threads to the branch of a tree. Sometimes the work was allowed to lie horizontally on the ground. A long stick was used as a *shuttle* for passing the weft threads through the shed. Indians may still be seen on some of the government reservations weaving on looms differing but little from those of primitive times. The Indians make up in skill what they lose by having such poor tools and often produce beautiful fabrics.

All the arrangements of warp and weft threads are based upon three primary weaves: the *plain*, the *twill*, and the *satin*. The plain weave makes the finest and strongest of all fabrics. In this the weft thread passes over one warp thread, under the next and so on across the fabric; when it starts back it passes under those threads that it passed over before and over the ones that it passed under before. Only one harness frame is needed to form the shed. By using this form of weaving we are able to produce the greatest possible number of thread crossings to the inch. This insures a strong and durable fabric.

The diagrams shown on pages 196, and 197, illustrate the plain, twill and satin weaves as plotted for a machine loom. The diagrams together with their descriptions are taken from the New International Encyclopedia. They will help us to a clearer understanding of the weaves. In A of each of the illustrations the horizontal



The Plain Weave

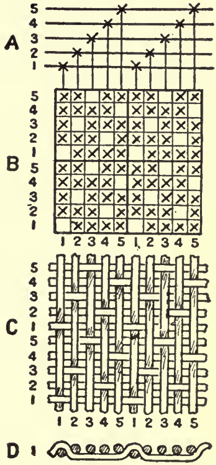


The Twill Weave

lines represent the loom harness with the disposition of the warp threads; the weave is shown at B plotted out on squared design or cross-section paper, each section representing the crossing of a warp and filling thread. The x marks show that the warp is above the filling at the points where they appear; the blank sections show that the filling is above the warp; the threads as interlaced are shown at C, and a section of the fabric cut through the warp is shown at D.

When the twill weave is used, the weft thread passes under two warp threads, over two warp threads and so on across the fabric; on its return, it goes over two threads, one that it passed over and one that it passed under before. This sort of fabric is woven with four harness frames. It has a stripe in the weave, which runs diagonally across the cloth.

In the satin weave, the weft thread passes over one warp thread, then under four warp threads and so on across. Upon returning, the weft thread passes under one warp thread, then over four warp threads and continues just as in the previous trip across, except that the warp threads passed under are shifted each time two spaces, either to the left or right. Five harness frames are required for the simplest satin weaves.



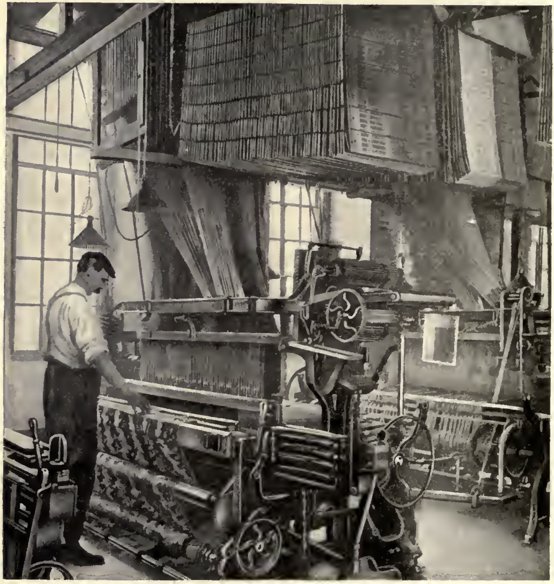
The Satin Weave

In the looms used in industry, we find that certain warp threads are raised automatically in order that a shuttle may pass through the shed. The same warp threads are then depressed and the shuttle returns through a newly formed shed. Our looms made in school should involve in their use these same principles if they are to make clear to us the movements involved in weaving. We must not only consider the industrial process of weaving, but we must also experience some of the difficulties involved in building a loom.

I

Directions for Making a Simple Loom

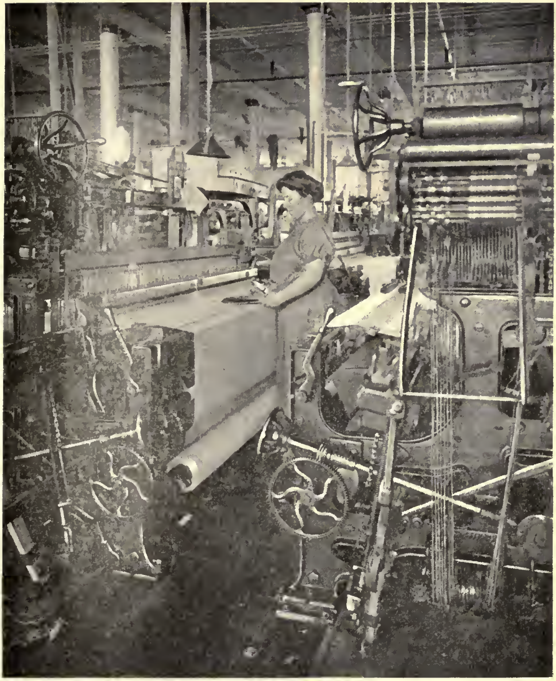
The three parts to be constructed are the loom frame, the harness frame, and the shuttle.



Courtesy of Cheney Brothers © *Keystone View Company*

Weaving Silk Tapestry on a Jacquard Loom

Let us use a soft wood with a fine grain such as white pine. Screws are needed to fasten the frame together. Small brads are used to *key*



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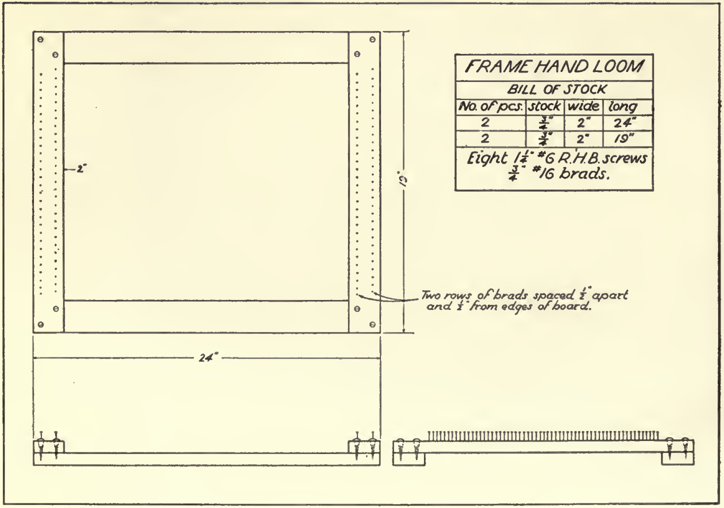
Weaving Woolen Cloth

the joints of the harness frame, and small brass rings, in stringing the harness frame.

THE LOOM FRAME

We shall make the wooden loom frame first.



Working Drawing of the Loom Frame

The *stock* needed may be ordered cut to exact size if we have but few woodworking tools. Two pieces 3/4 in. x 2 in. x 19 in. will be needed for the loom frame ends and two pieces 3/4 in. x 2 in. x 24 in. for the loom frame sides. These parts are fastened together at right angles at their ends. The steps in construction are as follows:

(1) On the loom end parts, locate and place points for two screw holes 3/8 of an inch from the edges, and 3/8 of an inch and 1 5/8 inches, respectively, from each end.

(2) Drill holes entirely through at these points using a 1/8 inch drill in a hand drill or brace.

(3) Place the loom ends on top of the loom sides with their ends even, the two parts forming a right angle.

(4) Drive the screws through the holes in the loom end parts with hammer and using a screwdriver, fasten the parts together securely.

(5) Smooth the frame with No. 00 sandpaper.

(6) On each loom frame end part, drive two rows of 3/4 inch No. 16 brads, driving each to within 1/4 of an inch of its head. This may be done accurately by placing a wooden strip 1/4 of an inch thick close to the brad being driven and driving until the hammer head comes down upon the wood. (An advertising yard stick will answer the purpose.) Place the brads 1/2 inch apart and arrange the two rows so that

the brads in the inside row are each time half way between two brads in the outside row. This is known technically as *staggering* the brads.

THE HARNESS FRAME

The harness frame is made as follows:

(1) Two sizes of stock will be needed; two pieces $\frac{3}{4}$ in. x $\frac{3}{4}$ in. x 4 in. for the uprights, and two pieces $\frac{1}{2}$ in. x $\frac{1}{2}$ in. x $14\frac{1}{2}$ in. for the horizontal parts.

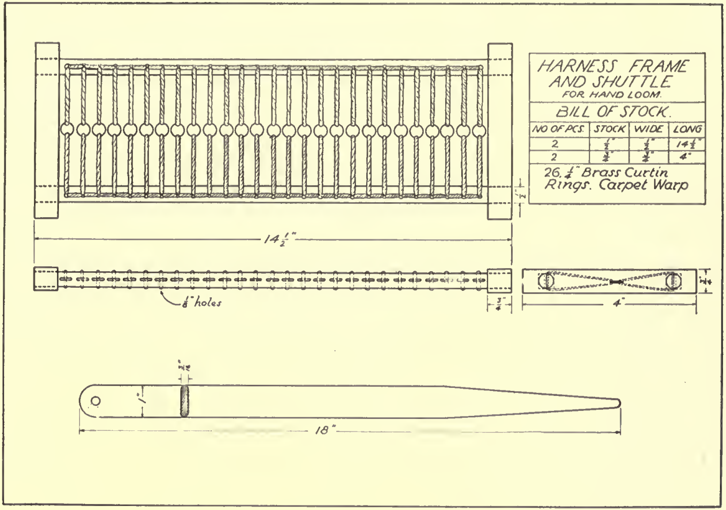
(2) Measure from each end of the upright parts on the same side $\frac{5}{8}$ of an inch and draw a line across the stock.

(3) Measure on these lines $\frac{3}{8}$ of an inch from one edge and place a point. Repeat these measurements on each end of both the upright parts. The points will be placed in the center of the stock laterally and $\frac{5}{8}$ of an inch from the ends.

(4) Bore $\frac{1}{2}$ inch holes entirely through the stock at these points, at right angles to the surface, using a No. 8 spur bit. Be careful not to split the wood. The holes will serve as *mortises* for the joints used in fastening the uprights and horizontals together.

(5) Mark off on the horizontal parts from each end, the width of one of the upright parts.

(6) Using a No. 8 Forstner bit, mark a $\frac{1}{2}$ inch circle on each end of each horizontal part centering the bit on the stock and revolving it backwards. In this way a circle is marked accurately.



Working Drawing of the Harness Frame and the Shuttle

(7) Cut down the ends of the horizontal parts, thus forming cylindrical *tenons* to fit the round mortises in the uprights. This is done with a sharp knife, cutting to the lines drawn with the pencil and with the Forstner bit.

(8) Mark a line lengthwise on one side of each horizontal part, in the center laterally, and mark off on this line 27 points ½ inch apart.

(9) At these points drill ⅛ inch holes entirely through the stock.

(10) *Assemble* the harness frame by fitting the tenons into the mortises. We have now produced four *mortise* and *tenon joints.* The joints may be glued if desired. The tenons are prevented from turning in their mortises by *keying* with a ¾ inch No. 16 brad driven in from one side of the uprights through each tenon. If cabinet makers' clamps are at hand the harness frame should be clamped for keying.

(11) Sand the harness frame with No. 00 sandpaper.

STRINGING THE HARNESS FRAME

String the harness frame in such a way as to place the ¼ inch brass rings in a straight line just half way between the horizontals. You may work out your own system, but be sure that you are systematic. The rings are held in place by an auxiliary string stretched half way between the horizontals and tied to the vertical

parts. The rings may be procured from a furniture or department store. They are known as $\frac{1}{4}$ inch curtain rings.

STRINGING THE LOOM

In stringing the loom the harness frame must be held in place temporarily by tying the vertical parts to the side parts of the loom frame. The warp string is now tied to the outside brad at one end of the loom frame; then it proceeds through the harness frame passing between the harness frame upright and the first brass ring on the first trip across, then on to the outside brad at the farther end of the loom, back through the first brass ring to the brad, and so on. When the last brad is reached the string is tied securely.

THE SHUTTLE

A shuttle may be made from an old wooden yard stick, or from strips of soft wood $\frac{3}{16}$ in. x 1 in. x 18 in. An eyelet to receive the weft string is bored with a $\frac{1}{4}$ inch Forstner bit and the shuttle is whittled to a point. It is then sanded.

II

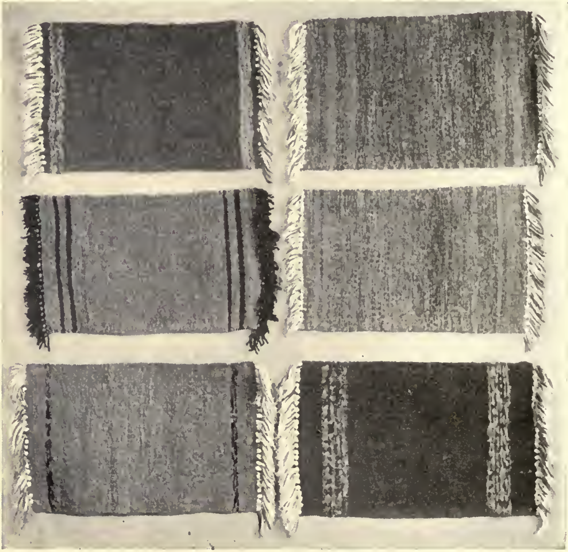
Directions for Weaving a Rug

(1) Cut the strings which hold the harness frame to the loom frame.

(2) Unwind about five yards of the weft (chenille is perhaps the best material for this, although

rug yarn, cotton roving, and even old rags torn into ½ inch strips will answer for the purpose).

(3) The shuttle is threaded and the weft passed through as one set of warp strings is raised by lifting the harness frame.

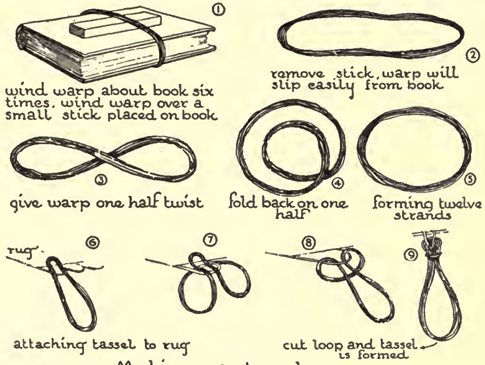


Rugs Woven in School on Looms Made by the Pupils

(4) When the harness frame is lowered the shuttle can make its return trip across.

(5) After each trip of the shuttle, the weft string must be *beaten* back tight against the

growing rug. In order to keep the rug from pulling in at the sides it is advisable to bring each weft thread around in the form of an arc before beating it back. This will provide for



Making a tassel

more slack in the center of the rug. In case it pulls in at the sides the slack can be stretched and the sides of the rug made parallel to one another. If this does not produce the desired results the weft string should be pulled back about an inch after each trip across, this inch of slack weft string being distributed over the center of the rug. When it has been entirely woven the rug is removed from the loom and the warp threads at either end tied.

TASSELS FOR THE RUG

A fringe of tassels will make the rug more attractive. The tassels are easily made by winding warp string several (perhaps 6) times around a small book. The cord should be wound loosely and the ends tied together when the cord is cut. It is well to wind the cord around a small stick of wood about ½ inch in thickness in addition to the book in order that the book may be easily withdrawn after the knot has been tied. When the stick is withdrawn the string will slip from the book readily. Fold the loop of 6 strands thus formed over on itself to make a smaller loop of 12 strands. This loop is interlocked on the rug where the first two warp threads have been tied. After the interlocking is accomplished cut each loop and a tassel will be formed. Fasten tassels entirely across both ends of the rug.

The Indian Blanket

Yonder amidst the blist'ring sands,
The Indian's rude built hogan* stands,
Under the blue and flawless sky
'Neath which fair crest and canyon lie.
Patterned with mystic, strange design—
With square and fret-work, with bar and line—
Here on the loom behold it grow;
The blanket of the Navajo.

* A house of earth built by the Navajo Indians.

Ploddingly woven, thread by thread,
In white and black, in gray and red,
Emblems bearing of life and death,
The lightning's path, the storm cloud's breath,
Slope of mountain and drench of rain,
The four winds, issue of peak and plain,
Village, and journey long and steep,
The blanket fills while graze the sheep.

Patient the swarthy toiler weaves;
For friend and alien alike achieves;
Pictures a country loved right well;
Thereof old legends; and may not tell
Whether a paleface eye afar
Will only a rug regard, bizarre,
Or see, interpreting the lore,
The Painted Desert on his floor.

EDWIN L. SABIN

This poem is used by courtesy of the "Youth's Companion."

EXERCISES FOR STUDY AND REVIEW

(1) Name four common textile materials and two articles of clothing which are made from each.

(2) What kinds of wool fibers are the best for making woolen goods?

(3) Tell how you would card wool fibers by hand. How are wool fibers carded by machinery?

(4) Why do most fibers have to be spun before they can be woven?

(5) Do you think silk fiber can be woven without first being spun? Why?

(6) How was spinning first done and how is it done today?

(7) Who was Eli Whitney and what did he contribute to textile manufacture? Refer to the encyclopedia.

(8) Describe the movements of a simple hand loom.

(9) Give a brief explanation of the picture entitled "Gossip," by Carl Marr.

(10) From what is pongee made? Muslin? Linen? Worsted?

(11) What kind of temperament should a good textile worker possess?

Suggested Reading about Textiles

Bush and Bush.—*Industrial and Applied Art Books*, V, VI, VII, VIII. Atkinson, Mentzer & Company.

Carpenter.—*How the World Is Clothed*. American Book Company.

Chamberlain.—*How We Are Clothed*. The Macmillan Company.

Chase and Clow.—*Stories of Industry*, Volume II. Educational Publishing Company.

Earle.—*Home Life in Colonial Days* (Chapter VIII, *Flax;* Chapter IX, *Wool;* Chapter X, *Handweaving;* Chapter XI, *Girls' Occupations*). The Macmillan Company.

———*Child Life in Colonial Days* (Pages 305 and 306). The Macmillan Company.

Forman.—*Stories of Useful Inventions* (Chapter IX, *The Loom*). The Century Company.

Kinne and Cooley.—*Shelter and Clothing* (Chapters VIII, IX, X, XI, XII). The Macmillan Company.

McGowan and Waite.—*Textiles and Clothing*. The Macmillan Company.

McMurry.—*Larger Types of American Geography* (Pages 164 and 198, *Cotton*). The Macmillan Company.

New International Encyclopedia (See *Carding*, *Spinning*, *Weaving*, *Cotton*, *Wool*, *Flax*, *Silk*). Dodd, Mead & Company.

Snow and Froehlich.—*Industrial Art Text Books*, V, VI, VII, VIII. The Prang Company.

Tarr and McMurry.—*New Geographies*, *Second Book* (Index under *Cotton*, *Dyewoods*, *Fiber Products*, *Flax*, *Hemp*, *Lace Making*, *Linen Manufacture*, *Rugs*, *Silk Industry*, *Textile Manufactures*, *Wool*). The Macmillan Company.

Tolman.—*Around the World* (Pages 35 and 180, *Wool*). Silver, Burdett & Co.

Toothaker.—*Commercial Raw Materials*. Ginn & Co.

Walton.—*The Story of Textiles*. John S. Lawrence, Boston.

Wells.—*How the Present Came from the Past*, Book Two (Index under *Flax*, *Cotton*, *Linen Cloth*, *Loom*, *Rugs*, *Spinning*, *Textiles*, *Weaving*).

Wilkinson.—*The Story of the Cotton Plant*. D. Appleton & Co.

Williams.—*How It Is Made* (Chapters X and XI). Thomas Nelson and Sons.

Woolman and McGowan.—*Textiles*. The Macmillan Company.

Courtesy of American Telephone & Telegraph Co.

VIII

COPPER

Copper and its *alloys* are the first metals of which we find mention made in history, and there are numerous objects made of copper or its alloys in existence to-day that archeologists claim date back to three thousand years before the time of Christ. But of the modern important producing fields only those of Spain, Germany, and Japan have a history that began earlier than 1835.

The first copper discovered in the United States was found in Massachusetts in the year 1632. In 1709, a company was organized in Granby, Connecticut, for the purpose of working the Simsbury mine, but only a small amount of copper was taken from this mine. Work was

Edgar M. Ward *Metropolitan Museum of Art*

THE COPPERSMITH

started on the copper deposits of New Jersey in 1719. The mines in Vermont, opened in the eighteenth century, were the principal source of American production until the opening of those in the Lake Superior region in 1884.

Jesuit missionaries discovered the Lake Superior deposits in the latter part of the sixteenth century. An English company was formed and the mines on the Ontanagon River were first opened in 1771, but the workmen were killed in an accident and the mine was abandoned. Copper mining was begun in Tennessee in 1850, neglected during the Civil War, and resumed in 1890.

Serious copper mining in the United States dates from 1884 with the production of a few tons of black ore, taken from a mine at Copper Harbor, Michigan. The beginnings of the Lake Superior copper industry were crude, indeed, but the growth was steady from the start, and within twenty years these mines became the most important producers in the country, and second only to those of Chile. The existence of the rich copper fields of the Lake Superior district was known to the American Indians, and it seems certain that these mines have been worked by a prehistoric race.

The United States produces more copper at the present time than any other country. The total amount produced in the United States

during the year 1911 was 1,090,000,000 pounds. This was at that time about sixty-five per cent of the total amount produced in the entire world during that year.

Montana is now the largest copper producing area in the world. Copper was first procured there in 1882. It was found in Arizona as early as 1872.

There are three general methods of extracting copper from its ores: the *dry*, *wet*, and *electrolytic* methods. The wet method is used the least of the three. It consists in placing the ores in an acid solution to dissolve the copper, which is then *precipitated* or settled to the bottom of the tank by the addition of suitable materials called precipitants. The dry method is the one generally used for *reducing* or refining the ore, especially when it is rich in copper. The method consists of two operations: first, *roasting* the ores; second, *smelting* the roasted ore in a *blast furnace*.

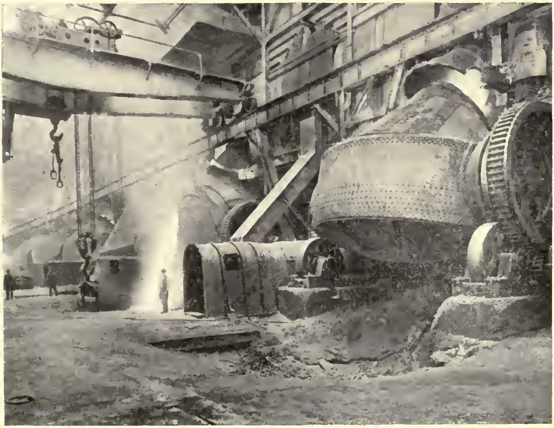
The ore is first *heap roasted* out of doors, the fuel being wood. One cord of wood is all that is needed to roast forty tons of ore. The wood is piled so as to form flues through the ore. The burning wood releases and sets fire to the sulphur of the ore which in turn burns and releases still more sulphur. The roasting pile will burn for several weeks.

The smelting of copper ore in a blast furnace is the process of reducing the copper from its

ores by subjecting them to an intense heat in a blast furnace called a *cupola*. Cupolas vary in inside diameter from twenty-two to one hundred inches. They are cylindric for a portion of their height and then taper to a cone to form the chimney. At the bottom are holes for raking out the cinders, and a *tap-hole* through which the molten metal is withdrawn. The metal is run into ladles from which it is poured into the molds. Coke is the fuel used, and the heat is obtained by turning into the cupola a blast of air heated to about eight hundred degrees Fahrenheit. The largest blast furnace in this country is that at the Washoe Works of the Anaconda Mine in Montana. It is eighty feet long, and has a capacity of two thousand seven hundred tons of ore a day.

The *Bessemer converter* is a type of blast furnace that is also used in the smelting of copper ores. These converters are cylindrical shells, made of boiler plate steel, usually about four feet in diameter and ten feet high. The shells are mounted on *trunnions* with a tilting device for emptying the *charge*. Air is blown through the melting ore. The condition of the ore is judged by the color of the flames issuing from the top of the converter. Fifteen tons of ore can be converted to a metallic state in about one hour by this method. The resulting metal is known as *blister* copper.

When an especially pure product is desired, or when the ore is known to contain a considerable percentage of gold and silver (as is often the case), the electrolytic method is used. This method consists of attaching a thick plate of



Courtesy of Anaconda Copper Mining Company

Converting Matte into Copper in a Bessemer Converter

blister copper called the *anode*, weighing about two hundred pounds, to the positive pole of a dynamo, and a thin sheet of copper, called the *cathode*, to the negative pole. These plates are placed in an acid solution, and an electric current is passed from the anode through the liquid to the cathode. This dissolves the anode, which

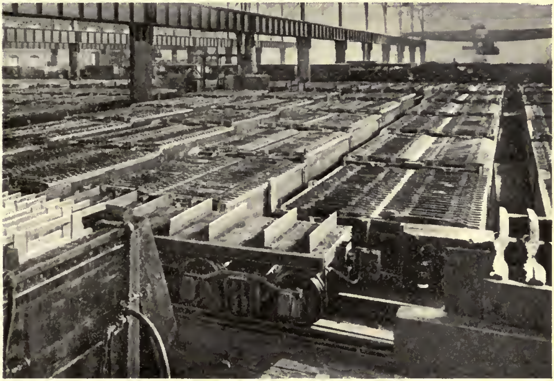
is deposited upon the cathode, the gold and silver falling to the bottom of the solution. The copper deposited upon the cathode is pure and

Courtesy of Anaconda Copper Mining Company

Casting Copper in Anode Molds

the precious metals at the bottom of the solution are recovered by the use of mercury and acids. The metals that drop to the bottom of the solution usually consist of silver, a little gold, and arsenic; the balance is made up of lead and impurities. The materials used in this process are sulphuric acid, bluestone, water, and a very

small quantity of salt. The solution is contained in large wooden tanks lined inside with lead and painted with tar. Electrolytic refining is cheap, and the bulk of the world's copper is treated by this method. The copper thus produced averages 99.93 per cent pure.



Courtesy of Anaconda Copper Mining Company

Electrolytic Copper Refining in Montana

Copper is *ductile* and may be drawn into fine wire or rolled into thin foil one two-hundredth of an inch thick. It becomes harder as it is worked, or pounded, but when heated to about six hundred and eight degrees Fahrenheit, it regains its malleability. It may be thrown into water while red hot and cooled quickly or it may be allowed to cool in the air; it will be equally soft in either

case. This process of softening by heating and cooling is known as *annealing.*

There are two methods of rolling copper into sheets, the straight rolling and the cross rolling systems. The straight rolling system consists in rolling a plate of copper between hardened steel rolls to about one-fourth to three-fourths of an inch in thickness, cutting it to the proper size for the desired *gauge* or thickness and weight of the sheet, then heating and rolling to the desired length. Cross rolling is much slower and more expensive and it is being superseded by the straight rolling system. Cross rolling is done by rolling the copper into sheets about twenty-five inches wide and about one-fourth of an inch thick, cutting to the desired weight, and rolling crosswise to the desired width.

Copper is often placed on the market in the form of *wire bars* about three and a half inches square and five feet long, averaging in weight about three hundred and fifty pounds. These are used for drawing down into wires of various shapes and sizes.

Some of the industrial uses of copper are

(1) wire for electrical work
(2) tubing
(3) roofing
(4) utensils
(5) manufacture of brass
(6) manufacture of bronze
(7) paint coloring

Perhaps the most important use of copper is

in the manufacture of wire for electrical work. Because of its high conductive quality it is especially well suited for the transmission of electrical current and in this electrical age the amount which is thus used is enormous. In 1911 in the United States alone about 731,000,000 pounds, or practically half the total amount cast, was cast in the form of wire bars. These are sent through a number of rollers, each set reducing the width and thickness of the bar and increasing its length until the gauge desired is reached. The bar to be reduced to wire is then drawn through a steel plate which has many accurately drilled holes, the holes being graduated in size from large to small. The bar is first drawn through the largest hole, and then through smaller and smaller holes until finally it is drawn through a hole the diameter of which is exactly that desired for the finished wire.

The use of copper for the manufacture of tubing has come to be quite extensive, due chiefly to the increased use of copper tubing in finer engineering work, and in the laboratory. Copper tubing in various kinds of heating coils, in steam gages, and in oiling systems will increase in use with the growing use of these appliances.

Copper is still used in the manufacture of utensils for the kitchen but aluminum is rapidly replacing it except in the large kitchens of hotels and restaurants. Many beautiful articles are to-day

Courtesy of American Telephone and Telegraph Co.

WEAVERS OF SPEECH

This illustration shows how the farms and the factories are connected with the offices and the city homes by the copper wires of the telephone and telegraph service which brings all into intimate coöperation regardless of distance.

made from copper which serve both a useful and a decorative purpose. (See illustrations on this page and on pages 224 and 225.)

The use of copper for roofing is significant, though, owing to the expensiveness of this form of roofing, its use is nothing like so extensive for the purpose as the use of sheet iron (often incorrectly called tin). Copper has an advantage over sheet iron in its ability to resist effects of the weather, a copper roof needing no painting, as does the so-called "tin" roof.

Courtesy of "The Roycrofters"

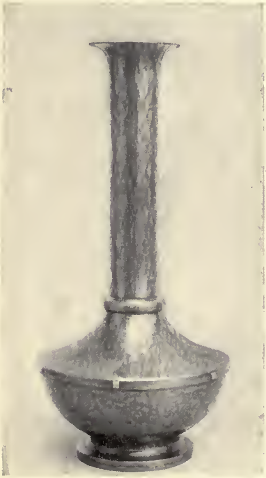
A Copper Lamp

Another important use of copper is in the manufacture of the alloys, *brass* and *bronze*. Brass, which is an alloy of copper and zinc, is more than half copper. This large proportion of copper in an alloy which is used so extensively is brass necessarily takes a great part of the annual supply.

Bronze is an alloy of copper, tin, and zinc, and sometimes of lead. Monument bronze, for instance, contains eighty-seven per cent copper, seven per

cent tin, three per cent zinc, and three per cent lead. Bell metal is seventy-five per cent copper, and twenty-five per cent tin.

As a coloring material for paints, copper is found in a number of forms, the most important of which are verdigris and emerald green. Verdigris is of a bright green color, inclining to blue. Emerald green is made from verdigris. It is a brilliant color and very poisonous.



Courtesy of "The Roycrofters"

A Copper Vase for Flowers

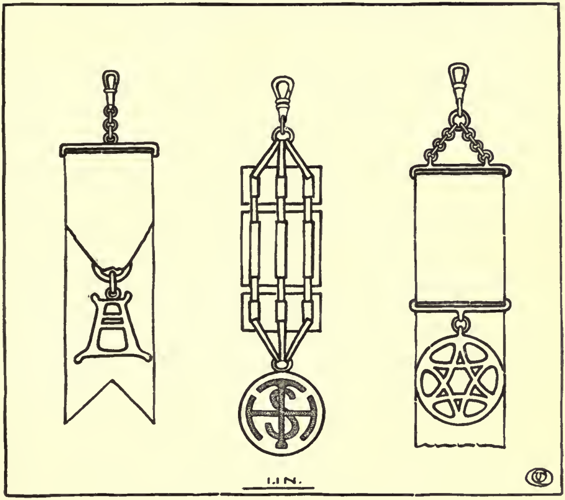
The making of a watch fob constitutes an interesting problem which is often carried out in schools. Some designs for fobs are shown on page 225. The sawing of the copper is illustrated on page 226. A design for a sconce is shown on page 228.

The Making of a Copper Dish

A problem that will demonstrate some of the characteristics of copper, is the making of a small pin tray. If the tray is to be a round one the method is as follows:

(1) Cut out of 18 gage soft sheet copper a circle ¼ inch larger in diameter than the plate is to be.

(2) Lap over the edge ⅛ inch all around the flat piece of metal, or beat it back; that is, simply

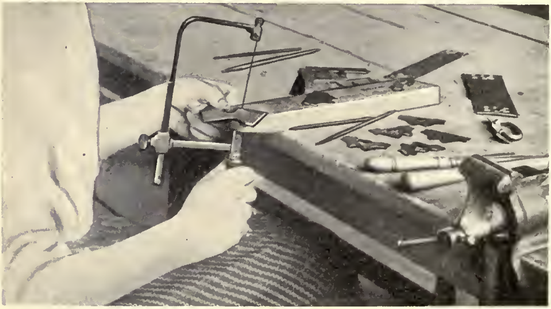


Designs for Fobs Made from Sheet Copper

beat the edges of the tray with a hammer, causing the metal to become somewhat thicker at the edge. Beat down the depression in the plate. To do this, first draw a line with compasses where the depression is to start; then hold the plate on the end of a block of wood and beat it

down over the edge of the block with a hammer, along the pencil line.

(3) If the plate is to have a deep depression, it will be necessary to anneal it, because it will become hard while being beaten. This is done by heating it to a red heat in a gas or other flame, then cooling it in water. (The cooling in water



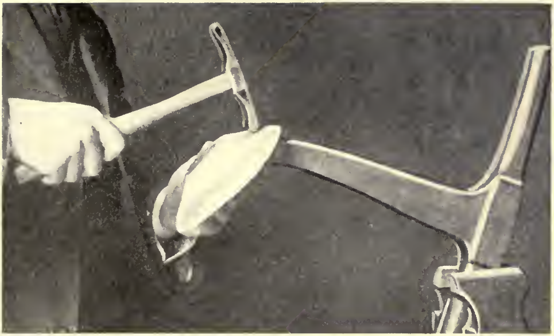
Courtesy of Augustus F. Rose

How Copper is Sawed

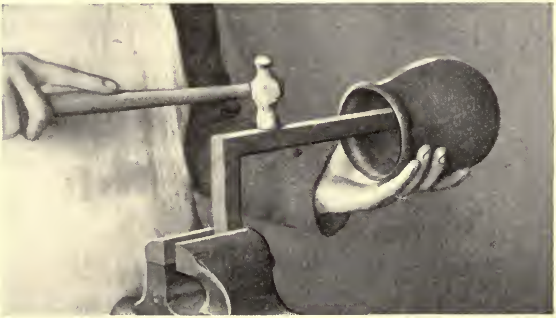
does not have the effect of hardening copper as it does steel or iron, but softens it.)

(4) If desired, the brim of the plate may have a border design *etched* on it. The design is painted on with asphaltum varnish, as are all parts of the plate which are not to be etched by the acid.

(5) The whole is placed, when dry, in a solution of 1 part nitric acid and 2 parts water in a stoneware or glass dish. The acid will, in a few



Hammering a Small Bowl out of Sheet Copper (Early Stage)

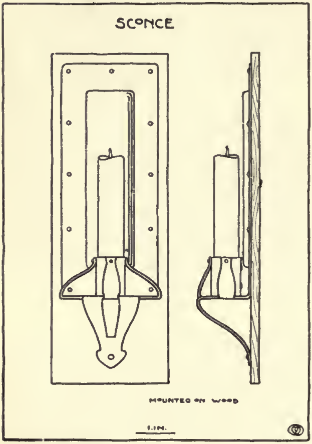


Hammering a Large Bowl out of Sheet Copper (Later Stage)

METHOD EMPLOYED BY CRAFTSMEN IN WORKING UP BOWLS FROM SHEET COPPER

minutes, begin to etch or eat away the metal that has been left bare.

(6) After the metal has been etched deep enough (which will take anywhere from thirty minutes to three hours, according to the depth desired), take the tray out of the acid and remove the asphaltum varnish by soaking the tray for about half an hour in turpentine, gasoline, or a solution of lye, after which the varnish can readily be wiped off.



Design for a Copper Sconce

THE THINKER

Back of the beating hammer
  By which the steel is wrought,
Back of the workshop's clamor
  The seeker may find the Thought,
The thought that is ever master
  Of iron and steam and steel,
That rises above disaster
  And tramples it under heel!

The drudge may fret and tinker
  Or labor with dusty blows,
But back of him stands the Thinker,
  The clear-eyed man who knows,
For into each plough or sabre,
  Each piece and part and whole,
Must go the Brains of Labor,
  Which gives the work a soul!

Back of the motors humming,
  Back of the belts that sing;
Back of the hammers drumming,
  Back of the cranes that swing,
There is the eye which scans them
  Watching through stress and strain,
There is the Mind which plans them—
  Back of the brawn, the Brain!

Might of the roaring boiler,
  Force of the engine's thrust,
Strength of the sweating toiler,
  Greatly in these we trust.
But back of them stands the Schemer,
  The Thinker who drives things through;
Back of the Job—the Dreamer
  Who's making the dream come true!

BERTON BRALEY

From "Songs of the Workaday World." George H. Doran Company.

EXERCISES FOR STUDY AND REVIEW

(1) Give some important uses of copper.

(2) Where are the copper ore producing fields in the United States?

(3) How is copper secured from the ore?

(4) What is meant by annealing? How is copper annealed?

(5) How is copper wire made?

(6) Why are pennies made from copper?

(7) What metals are used in making brass? Bronze?

(8) How are bowls and vases made by hand from sheet copper?

(9) How extensive is the use made of copper in industrial work?

(10) Make a cut paper poster design illustrating some phase of the copper industry. You may use two colors and black. Supply a carefully lettered title.

(11) Explain the illustration, "The Coppersmith," by Ward.

Suggested Reading About Copper

Bishop and Keller.—*Industry and Trade* (Index under *Copper*). Ginn & Co.

Brigham and McFarlane.—*Essentials of Geography*, Book II (Pages 144, 322, 365). American Book Company.

Carpenter.—*North America, Geographical Reader* (Pages 196 to 198). American Book Company.

Fairbanks.—*Stories of Rocks and Minerals* (Pages 151 to 154). Educational Publishing Company.

Rodgers and Others.—*Trade Foundations* (Index under *Copper*). G. M. Jones, Indianapolis.

Rose.—*Copper Work*. The Davis Press.

Tarr and McMurry.—*New Geographies*, Second Book (Index under *Copper*, *Minerals*, and *Mining*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials*. Ginn & Co.

Wells.—*How the Present Came from the Past*, Book Two (Index under *Alloy*, *Bronze*, *Copper*, *Saw*, *Smelting Ores*). The Macmillan Company.

Fred Dana Marsh

ENGINEERING

IX

IRON AND STEEL

Iron exists in its natural state as ore, which is a combination of iron and other elements in the form of rock or earth. The modern method of mining, known as *open pit mining*, is more in the nature of quarrying than of mining in the ordinary sense, the ore being scooped from the surface of the ground by huge steam shovels. Mining in the Lake Superior regions is done by this method. The ore is loaded by machinery directly upon the cars for transportation to the wharves, or to chutes leading to the waiting boats. When the ore is obtained from the mine in pieces too large for convenient handling, as is often the case, it is run through a crusher before being delivered to the cars.

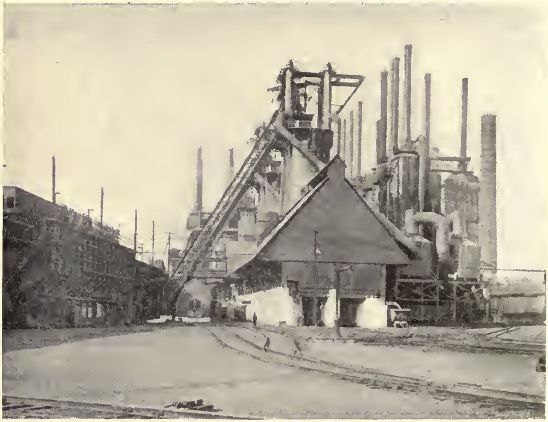
Iron is extracted from the ores by the action

of heat, the process being known as *reduction*. This is done in a huge furnace known as a *blast furnace*. The blast furnace is a tall, slightly tapering shell made of iron plate and lined with fire bricks. These shells vary from twenty to a

Derrick Unloading Ore from a Boat at a Wharf

hundred or more feet in height, and are about fifteen feet in diameter. The ore, along with the fuel (coke) and a *flux* (limestone) are dumped into the furnace through a hole in the top which is closed by a large movable lid called the *bell*. The coke is procured by burning coal in furnaces constructed especially for the purpose. The flux

is put into the blast furnace with the fuel in order to make the ore melt more readily. The *charging* or filling of the furnace is to-day done entirely by machinery, the materials being carried to the top of the furnace by elevators, and unloaded



Blast Furnaces

automatically into it at just the proper time. A blast of hot air blown into the furnace at the bottom passes up through the ore and out at the top in the form of a gas, which is also used for fuel. As the charge descends in the blast furnace it is subjected to higher and higher temperatures. Finally the iron in a molten state reaches the bottom of the furnace where it is poured off.

In the older method of blast furnace operation, the molten iron was removed through a *tap hole* at the bottom of the furnace and run into trenches or *molds* in the sand floor around the furnace, where it was allowed to cool, and was then known as *pig iron*. In modern smelting works the molten metal from the furnace is run directly into iron molds attached to an endless chain which carries the molds to a point where they are cooled either by being sprayed with water or by passing through a tank of water.

Where the contents of the blast furnace are to be converted into steel at once, the molten metal is carried in movable tanks directly to the steel furnaces. The iron is poured from the tanks into a mixer, in which the products of the various furnaces are mixed to insure uniformity of quality. From the mixer the metal is transferred to the *Bessemer converter*. The converter is barrel shaped with the top open. It is hung at the middle. Molten metal from the mixer is poured into the converter and a blast of cold air is blown in at the bottom which passes up through the molten metal and out at the top in a roaring flame which is red at first, but which gradually changes to white and then to a weak, light blue. These changes of color indicate changes in the metal, and the appearance of a certain tint of blue indicates that the conversion into steel is complete. The air blast is then shut off. The contents of the con-

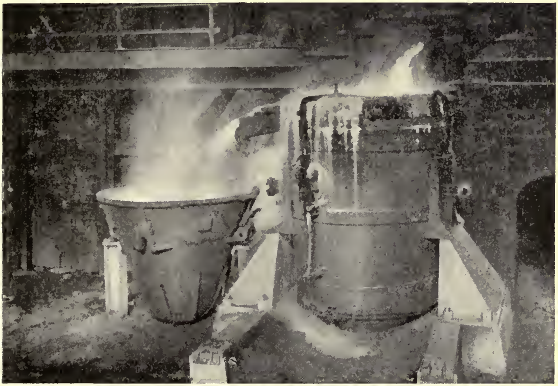
verter are now drawn off into molds of any desired shape and size, and when cooled the *steel* is ready for shipment. Pig iron is also converted into steel by means of the *open hearth* method which will not be described here. The illustration on page 237 shows one method of separating the slag from the metal.

A Bessemer Blow in Full Swing

In the larger steel plants the metal is not allowed to cool, but is sent direct to the *rolling mills*, being drawn off from the converter into *ingot molds* (See page 238) mounted on small cars. When the metal has cooled sufficiently these molds are removed and the glowing *ingots* are ready for shaping in the rolling mills.

Rolling mills are provided with machinery for working steel ingots into rails, bars, plates and rods, by repeatedly passing them, while intensely hot, between cylindric rolls. The rolls work in pairs, one above the other, and are of such shape

as to impart the desired outline to the metal passing between them. (See page 239.) The operation is continuous through these pairs of rolls, each succeeding pair causing the ingot to become narrower and longer.



Molten steel is shown flowing from the open hearth furnace into a ladle. The smaller thimble-shaped vessel receives the slag which rises to the top and flows over into it.

Not all the product of the blast furnace goes to the Bessemer converter to be made into steel. Much of the pig iron produced by the blast furnaces is sent to the foundry where it is *cast* into machine parts by the use of sand molds. These machine parts are said to be made of *cast iron.*

Founding or metal-casting is the art of forming in sand, by means of a *pattern*, a chamber or *mold*

of any given size and shape, later to be filled with molten metal which is allowed to solidify. Iron

Pouring Molten Steel from Ladle into Ingot Molds

founding may be separated into three operations: (1) the forming of the mold, (2) the melting of the metal, (3) the pouring of the metal into the mold.

The process of molding in sand, using a *flask* (See illustration on page 242), may be described as follows: The lower part of the flask, called the *drag*, is filled with damp sand and half of the pattern imbedded in it. The upper part of the flask, or *cope*, is then placed in position on the

Removing the Ingot Molds from the Steel Ingots as soon as the Metal has Hardened

drag, and sand is *rammed* tightly around the other half of the pattern. The two flasks kept tight together are then turned bottom up, and the sand first loosely placed in the drag, is removed. A thin layer of dry *parting sand* is sprinkled over the sand in the cope and the drag is refilled with sand and firmly packed. The two parts are now reversed to the original position and separated,

the parting sand making it possible to separate the two bodies of molding sand. The pattern is then removed, any imperfections of the mold are remedied by hand, and the two parts are again placed together. The molten metal is

Rolling Steel Bars

poured into the mold through suitable passages, called *gates*, which are cut in the parting surface of the sand from the edge of the mold to a vertical hole called a *sprue pin hole*, made by inserting a tapered wooden pin, called a *sprue pin*, in the sand when it was packed around the pattern. The iron is melted in a cupola, or foundry furnace. Iron thus molded is called cast iron.

Wrought iron can be produced either from the

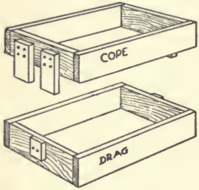
ore directly, or by the conversion of pig iron in a *puddling furnace*. In the process known as *puddling*, pig iron is melted and subjected to a flame until the carbon is burned out. The iron is heated until it melts into a thick fluid mass.

Courtesy of The Industrial Arts Magazine

Pouring Metal into the Molds

While in this condition it is thoroughly stirred and worked by means of a long iron bar, to insure all parts of the iron's being treated. This working is called *rabbling*. The puddling process is carried on at a high temperature with the iron in a semifluid state; it causes most of the impurities to

be burned out or else separated as *slag*. When the process is nearly completed the iron becomes stiffer and is known as a *mat*. The workman divides this into masses of about one hundred and sixty pounds each, and with his bar rolls them into balls on the hearth of the furnace. A small amount of slag will adhere to the balls and be rolled up in them. To get rid of this slag the balls are removed from the furnace and passed through a *squeezer*, which is a form of press that forces out the slag and presses the iron into a solid mass, after which it is passed through rolls and reduced to the form of bars. It is then known as wrought iron and is ready for shipment.



The Flask

Iron and steel are often shaped by *forging*. The blacksmith heats a bar of wrought iron red hot and shapes it over the *anvil* with his hammer. Horse shoes were formerly made entirely by this method. Nails were once hand forged, too. The modern blacksmith buys his horse shoes ready made and fits them by reheating and reshaping. Today nails are turned out in thousands by automatic machines.

Hand forging is still employed in repair work and whenever small numbers of forgings of odd shape are desired. The modern blacksmith does

a great deal of his work on the *trip hammer* which is operated by electricity or steam. It gives heavier and more frequent blows than can be struck with the hand hammer or sledge.

When a large number of forgings are wanted, all just alike, the *drop forge* (see page 244) is used. The hot iron or steel is pounded into shape by a great hammer which sometimes weighs several tons. The hammer drops or is forced by steam down upon the anvil, upon which is placed a *die* containing a sunken form of the desired shape and size. The hammer itself also carries a similar sunken form to provide for the other half of the object to be forged. As the hammer drops, a bar of red hot metal is inserted between the two dies. Usually two blows are given. The metal is then transferred to a second machine which trims off the projecting edges as the object forged is punched through another die containing a hole the exact shape of the contour of the forging. Wrenches are drop forged.

As one approaches a great steel mill and hears almost a mile away the powerful blows and feels, as he approaches, the ground beneath him throb and quake at the mighty blows struck by the drop forges, he is amazed at the superhuman strength of these labor saving Titans contrived by man to do so much of the work of the world.

The Casting of a Paper Weight

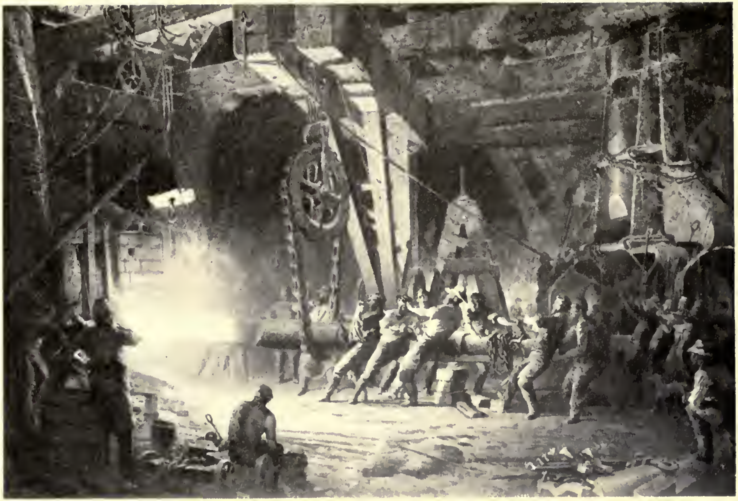
An exercise which gives an insight into the indus-

trial processes of *pattern making* and metal casting is the making of a lead paper weight or some other simple article which is easily cast in this metal. It

Drop Forging

will be necessary first to construct a molding flask.

This consists of two box-like frames, just alike, 2 inches high, 4 inches wide and 6 inches long (inside dimensions), and a bottom board ½ inch thick, 6 inches wide, and 8 inches long. The two frames will be placed one on top of the other, the lower frame resting on the bottom board. The



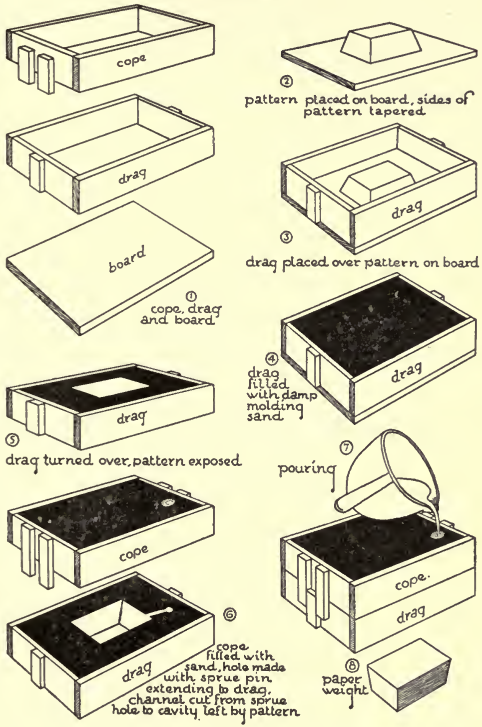
Weir *Metropolitan Museum of Art*

THE FORGING OF THE SHAFT

upper frame is the cope and the lower frame, the drag. In order that these two parts of the flask shall come together in the same position each time it will be necessary to provide some sort of registering device. This may we done by nailing 2 strips (about ½ inch thick, 1 inch wide, 2 inches long) on the outside of the cope and 1 on the drag at one end, so that the ends of the strips at one end will project down the side on the outside of the drag, and by nailing similar strips to the opposite end of the frames. When the two parts of the flask are brought together they must always be in such position that the strips projecting from the cope will fit over the strip fastened to the drag as shown on page 247.

A *pattern* is now made. This pattern will be an exact model, in wood, of the article to be cast. The sides of the pattern are tapered, however, the pattern being smaller at the top than at the base. This tapering is called *draft*, and is put on to facilitate drawing the pattern from the sand, as will be seen later. The pattern should be shellacked.

The molding outfit consists of three parts—the cope, the drag, and a board. In making the mold or *molding*, as it is called, the pattern is placed, large side down, on the board. The drag is placed over and around it. The drag is then filled to the top with damp molding sand, or other fine sand, well tamped. Another board is placed on top of this and rubbed gently so as to make an even, compact surface on the sand. The drag is then



Casting of a paper weight

turned over and the board removed so that the pattern is exposed. The cope, or upper portion of the flask, is then fitted to the drag. A layer of fine, dry sand, technically known as *parting sand*, is sprinkled over the exposed surface of damp sand in the drag. Then the cope is filled with the damp molding sand, well tamped. The sprue pin is set up in the sand so that it projects into the sand in the drag at a point conveniently near to the position of the pattern in the sand. The sprue pin is a tapered cylinder. For this small work a new stick of chalk will answer the purpose very well. The sand in the cope is packed around this pin and the pin is then withdrawn, leaving a hole through the sand in the cope to the sand in the drag and a little way into this. A small channel is now cut from the end of the sprue hole to the cavity left by the pattern. This channel is called a *gate*. To cut the channel, it is necessary to lift the cope from the drag. The pattern is removed by driving lightly into it a sharpened nail, tack, or any other instrument which may serve as a handle for withdrawing it. It is now evident that unless the pattern were larger at the base than at the top it would be very difficult to withdraw it without breaking the sides of the mold left by it in the sand. To allow for the escape of steam which will be formed when the hot metal is poured into the damp sand mold, *vents* are made in the sand of the cope by punching a large nail

nearly through the sand of the cope. The cope and drag are then fitted together again and all is ready for the pouring.

The lead may be melted in an iron pot on an ordinary stove. It should be poured slowly but steadily into the sprue hole until the latter is completely filled. After allowing sufficient time for cooling, the *casting* may be removed from the flask and the sand cleaned from it. The projection of metal from the gate may be removed by breaking or sawing, and the rough place left filed smooth.

Teacher's Note: For a project involving the use of sheet iron the making of a sugar scoop or a cup is most appropriate. A satisfactory way to construct such utensils is to make use of empty fruit or condensed milk cans which may easily be cut to the desired shape, and a handle made and soldered on as required. The making of cooky cutters presents another good field. The sheet iron needed for these articles may be obtained from various sorts of "tin" cans and boxes. Opportunity for individual expression will be afforded, and at the same time the qualities and characteristics of iron and tin will be illustrated. The use of the alloy of tin and lead, viz., solder, will be involved also.

Another excellent problem is the making of a sconce for a candle. This is easily made from a can. A handle is soldered to the back of it and a receptacle to the inside for holding the candle. The sconce may be painted with enamel paint and decorated with an interrelated border pattern in complementary or analogous colors.

The Forging of the Anchor

"Hurrah!" they shout, "leap out, leap out": bang, bang, the sledges go;
Hurrah! the jetted lightnings are hissing high and low;

A hailing fount of fire is struck at every squashing blow;
The leathern mail rebounds the hail; the rattling cinders strew
The ground around; at every bound the sweltering fountains flow;
And thick and loud the swinking crowd, at every stroke, pant "Ho!"

Swing in your strokes in order, let foot and hand keep time,
Your blows make music sweeter far than any steeple's chime!
But while ye swing your sledges sing; and let the burden be,
The Anchor is the Anvil King, and royal craftsmen we;
Strike in, strike in, the sparks begin to dull their rustling red!
Our hammers ring with sharper din, our work will soon be sped;
Our anchor soon must change his bed of fiery rich array
For a hammock at the roaring bows, or an oozy couch of clay:

In livid and obdurate gloom, he darkens down at last.
A shapely one he is, and strong as e'er from cat* was cast.
A trusted and trustworthy guard, if thou hadst life like me,
What pleasures would thy toils reward beneath the deep green sea!

Samuel Ferguson

In "Choice Readings," Robert M. Cumnock. A. C. McClurg & Co.

Exercises for Study and Review

(1) How is iron secured from the ore?

(2) How is pig iron made into steel?

(3) Compare iron and copper considering (a) color, (b) weight, (c) hardness, (d) commercial value.

* A boat employed in England in the coal trade.

(4) What is meant by founding?

(5) What kinds of iron are used in forging?

(6) Name some iron products which are made by forging. By casting.

(7) Make a cut paper poster picture to illustrate some phase of the iron and steel industry. Use two colors with black and gray.

(8) Why are nails usually made from iron and steel?

(9) Make a list of iron and steel products in and about the school building. Classify these as iron or steel and as cast or forged.

(10) Discuss the painting, "The Forging of the Shaft," by Weir.

(11) Why are the metal working trades attractive to boys possessing the necessary qualifications?

(12) What opportunities for advancement are offered in the machinist's trade?

Suggested Reading about Iron and Steel

Bishop and Keller.—*Industry and Trade* (Index under *Iron, Iron Industry, Iron Manufacture*). Ginn & Co.

Carpenter.—*North America; Geographical Reader* (Pages 192 to 196 and 236 to 238). American Book Company.

Fairbanks.—*The Most Useful Mineral, Iron* (Pages 145 to 150). Educational Publishing Company.

Forman.—*Stories of Useful Inventions* (Chapter IV, *The Forge*). The Century Company.

Hood.—*Iron and Steel* (Common Commodities Series). Isaac Pitman & Sons.

McMurry.—*Larger Types of American Geography* (Page 135, *The Iron and Steel Business*). The Macmillan Company.

New International Encyclopedia (see *Iron* and *Steel*). Dodd, Mead & Co.

Rodgers and Others.—*Trade Foundations* (Index under *Iron*, *Steel*). G. M. Jones, Indianapolis.

Smith.—*The Story of Iron and Steel.* D. Appleton & Co.

Spring.—*Non-technical Chats on Iron and Steel.* Frederick A. Stokes Company.

Tarr and McMurry.—*New Geographies*, Second Book (Index under *Coke*, *Iron Manufactures*, *Iron Ore*, *Minerals and Mining*, *Steel Manufacturing*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials.* Ginn & Co.

Wells.—*How the Present Came from the Past*, Book Two (Index under *Iron*, *Metal*, *Ores*, *Smelting Ores*, *Steel*). The Macmillan Company.

Williams.—*How It Is Made* (Chapters XIV, XV, XVI, XVII, XVIII). Thomas Nelson and Sons.

X

THE SOAP INDUSTRY

It is likely that the first substance used for cleansing purposes was the juice of certain plants. The ancients used *fuller's earth,* a soft earth substance resembling clay though it is not plastic like clay. Fuller's earth later came to be used extensively in fulling woolen cloth; that is, in cleaning and shrinking it. The earth was spread over the cloth and stamped and rubbed in with the feet. By this method of scouring, the greasy matter and dirt were removed, fuller's earth having the property of absorbing both grease and dirt.

It would seem from statements made by the Roman historian, Pliny, that the Gauls were the original inventors of *soap* as we know it to-day. Their best soap product was a combination of *goat's fat* and the *ashes of beech wood.* The Romans, after their invasion of Gaul, introduced the art of soap making into Italy. A soap maker's shop was discovered in the ruins of Pompeii, an Italian city

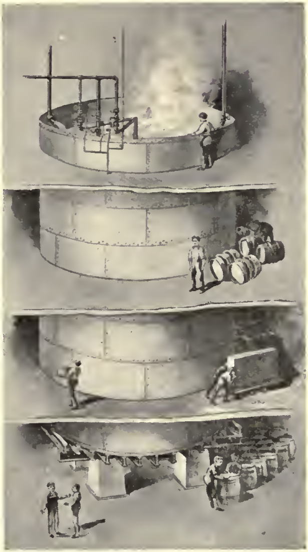
which was buried beneath the ashes of Mt. Vesuvius, in 79 A. D. The ruined shop is still exhibited to tourists.

In the eighth century, soap was manufactured quite extensively in Italy, Spain, and Germany. In these countries the industry was carried on both as a household art and as a trade. Strange to say, it was not introduced into France until the thirteenth century, and yet in France were to be found conditions most favorable to the production of the necessary raw materials. The exact period in which soap was first manufactured in England is uncertain. The work was probably begun sometime during the fourteenth century.

Soap making has passed through a long period of rude and unscientific development; at present, however, it is commanding the attention of scientific men. The first invention of importance which led to its perfecting was that of Leblanc, a Frenchman, who discovered a way of obtaining *soda* from common *salt*. Rapid advance in chemical knowledge has been a means of greatly improving the art of soap making in that many more *saponifiable* substances than were at first known have been introduced. Among these are *oils* (olive, cocoanut, fish, palm, and castor) and other fatty substances (as lard, and tallow). The prejudice men of scientific ability felt against entering the soap making industry, was at first so great that until about sixty years ago soap makers seldom,

if ever, consulted scientific men. Fortunately, this prejudice has died away.

In making soap to-day a large kettle is used, in which the contents can be boiled by one of two methods. In one, steam is blown directly into the liquid through a coil of pipe that has numerous holes punched in it. This is called the *open coil* and it lies on the bottom of the kettle in the soap liquid. The second method consists in passing steam through a *closed coil.* In this case the steam does not touch the soap liquid but the heating of the liquid takes place in the same way as does the heating of the air in a room by a radiator. A kettle that will hold 100,000 pounds is fifteen feet in diameter and twenty-one feet high, but only a little more than half this amount of soap can be made in a kettle of this size because con-



A Soap Kettle Nearly Four Stories High

siderable room must be allowed for the soap liquid to rise as it is being boiled. The huge soap kettles are usually made of three-eighth inch iron boiler plate. Melted fat and *lye* are run into them and boiled until saponification begins to take place; that is, until the soap material feels dry and firm as it is tested between the fingers. It is salted

Courtesy of Procter & Gamble Co.

Top Floor of Kettle House

with common salt, which causes the soap to separate from the lye and *glycerine*. The adding of more salt causes the soap to rise to the top and to *solidify*. The liquid is left standing in the kettle until all the soap in it rises to the surface, the lye being drawn off at the bottom.

More strong lye is added as the boiling is continued, this time until the material has fully saponified. The experienced soap maker knows by sight and touch just when complete saponifica-

H. H. Wessel *Courtesy of Procter & Gamble Co.*

THE SOAP MAKER

tion has been accomplished. (See page 257.) The material is again allowed to stand and the lye is drawn off a second time. The soap is then boiled with water and once more allowed to settle. In the process of settling, the remaining free lye, and the dirt and other impurities are separated from it.

Filling Frames with Soap as It Comes from the Crutcher

After standing for several days during which time it remains hot and liquid, the material is finally pumped into a *crutcher* which consists of a broad vertical screw working in a cylinder placed in a large tank. Here it is thoroughly mixed, and perfume, scouring or other materials are added if desired. The hot semi-liquid soap is now drawn off into rectangular *frames* which hold about one thousand pounds each. Here it is allowed once again to solidify. After this final solidification has taken place the sides and ends of the frames are removed and the mass of soap is cut by means of wires into slabs. which in turn

are recut, lengthwise and then crosswise into the size desired for the commercial bars. The bars of soap are now allowed to stand on racks, exposed to the air, so that they may dry partially and *season*. They are then *pressed*, *wrapped*, *packed* in

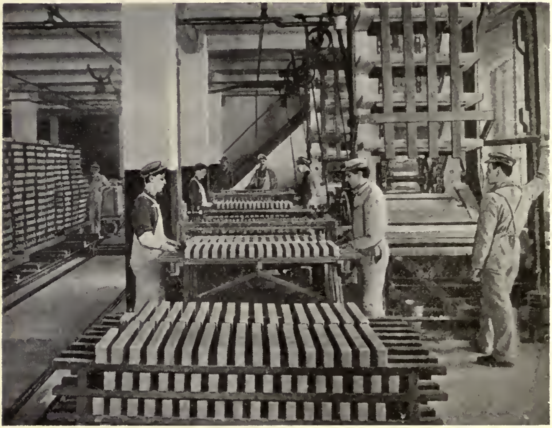
Removing Sides and Ends from Frames

boxes, which usually hold one hundred bars each and *stored* in large storerooms.

Tallow, palm oil, and cocoanut oil are often used in making white soap. Yellow soaps are made in the same way, except that rosin is added. Castile soap is usually made from pure olive oil. The following list of the common soaps is suggestive of the variety now in constant use:

1. Toilet Soaps
    a. common

b. medicated
c. paste
d. liquid
2. Laundry Soaps
a. white
b. yellow



Cutting Soap Slabs into Bars

3. Soap Powders
a. washing
b. scouring
4. Soft Soaps
5. Scouring Cakes

To Make Five Pounds of Soap

(1) Melt in a pan or kettle 2¾ pounds of clean grease or tallow free from salt.

(2) Set the grease aside to cool and while it is cooling dissolve ½ pint of soda lye (obtained from any grocery store) in 1¾ pints of cold water. The water will at once begin to get hot. Be careful not to get any of the lye solution on your hands or clothing.

Soap on Racks Going into Dryer

(3) When the lye solution has cooled to blood heat pour it slowly into the lukewarm grease. Pour the lye into the grease, not the grease into the lye, at the same time stirring until the lye and grease are thoroughly combined and the mixture becomes smooth and thick. Do not stir too long or the grease will separate from the lye.

(4) Pour into a mold or wooden box lined with paper or with cotton cloth.

(5) Cover and place in a warm room for a day or two.

(6) Cut the soap while still soft into cakes of attractive proportions, using fine twine or a small gage wire.

(7) If on examining the soap you find it streaked

with greasy layers it has not saponified thoroughly. This is caused by improper stirring. In this case, it will be necessary to cut the cakes up and put the material back into the pan with ½ pint of water. The mixture should boil until the soap is entirely melted and the liquid has become clear. Pour into the mold again, cover, and set aside for two or three days.

Caution: The grease must be clean and free from salt. After melting over the fire it must be allowed to cool until it is just warm to the hand. The lye solution must be lukewarm. Be sure, as has been stated above, to stir the lye into the grease and not the grease into the lye.

Soap Song

Time was, back in the sixties,
When soap, both soft and hard,
Was each recurring springtime
Made, out in grandma's yard.
Then if the moon was waning
And the sun had come up red,
The batch was sure to turn out good,
My old grandmother said.

The ashes, saved all winter,
Were used to make the lye,
And bits of fat and meat rind,
I can not tell you why,
Were put into the kettle
'Neath which a fire was made;
And I to keep it burning bright
A penny new was paid.

But that sweet smelling bar of soap
With which you wash to-day
Was made in a huge factory,
A hundred miles away,
And scores and scores of workers
Had each his part to do
That this pure product of his pains
Might now be used by you.

And many skillful chemists
Have studied day and night
Through years of toil and trial
To make our soap just right;
And perfumes, oils, and healing herbs
From near and distant lands
Combine in many kinds of soap
With which we wash our hands.

FLORA MAE SHEPARD

EXERCISES FOR STUDY AND REVIEW

(1) How was cloth cleaned before soap was invented?

(2) What two things are essential in soap making?

(3) How was soap originally made in the home?

(4) How is soap made in the factories?

(5) With what varieties of soap are you familiar?

(6) What kinds of stores handle soap products? Which stores carry toilet soap? Laundry soap? Tooth paste?

(7) What are some of the qualities which a good toilet soap should possess? A good laundry soap?

(8) Tell the story suggested by Wessel's "The Soap Maker."

(9) What are some of the advantages and disadvantages of employment in a laundry?

(10) In what cities of the United States is soap made?

(11) Why do you think these cities were chosen by the manufacturers?

Suggested Reading about Soap

Earle.—*Home Life in Colonial Days* (Pages 253 to 255). The Macmillan Company.

Tarr and McMurry.—*New Geographies*, Second Book (Index under *Fibre Products*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials*. Ginn & Co.

Williams.—*How It Is Made* (Chapter V, *Candles and Soap*). Thomas Nelson and Sons.

Arthur Covey *Courtesy of Lord & Taylor*

VENETIAN GLASS BLOWING

XI

THE GLASS INDUSTRY

Glass has been used by man in the making of useful articles and ornaments, since the dawn of civilization. The earliest glass articles were of an ornamental character, being substitutes for precious stones, or used for architectural decorations of buildings. These early glass articles were generally molded, the molding being done in much the same way as metal castings are molded to-day.

The glass industry in the United States began in the Virginia colony soon after 1607. The works stood in the woods about a mile from Jamestown. This was the first productive industry to be established in the New World. Not many years afterward, in 1622, a second glass factory was erected for the manufacture of glass beads to be used in trading with the Indians who were great lovers of beads. It is possible that some of the

Charles Frederick Ulrich *Metropolitan Museum of Art*

GLASS BLOWERS OF MURANO

glass beads now found in old Indian graves were made in one or the other of these two factories at Jamestown.

Glass is made today in many different ways by the use of a variety of materials; but in its simplest form, its constituents are glass sand, or *silica*, *soda ash*, and *lime*. The industry thrives best where these materials are most easily obtained. Glass sand, the principal ingredient, is found in Pennsylvania, Ohio, Illinois, West Virginia, New Jersey, Missouri, and in some other states of the Union. The work is carried on most successfully in those parts of our country where there is an abundant supply of natural gas, this being a cheap and desirable fuel for melting the raw materials.

The United States ranks among the leading countries of the world in the production of glass, but because a great portion of it is utilized at home, little is left to be exported. Other countries which produce glass in large quantities are Belgium, Austria, Germany, and France.

Several varieties of glass are made at the present time, the two principal kinds being *lime glass*, which is a compound of silica, soda ash, and lime; and *lead glass*, which is a compound of silica, soda ash, and lead. Lime glass is harder than lead glass and most of the cheap grades therefore are made from lime. Lead glass is clearer and more brilliant, and being softer, it may be cut. Our

most beautiful articles of clear glass are made with lead. Practically all colors are obtained in glass, variation in color being produced by adding *salts of metal*, as of *iron* to produce red, of *copper* to produce green, and of *cobalt* to produce blue.

Making Crucibles

The raw materials for glassmaking are ground to a fine powder called *glass batch* or *frit*. The grinding is done in a ball mill similar to that used in grinding the raw materials used in the manufacture of portland cement and of glazes. (See chapter on Cement and Concrete, page 149, and on Pottery, page 113.)

The ground materials used in the making of glass are mixed and then placed in a melting pot or *crucible* made from fire clay. A temperature of three thousand degrees Fahrenheit is required

to *fuse* or melt them together. In making ordinary *window glass*, the molten glass, called *metal*, is *gathered* on the end of a *glass blower's tube* which is an iron pipe, about five feet long, one end of which is provided with a wooden handle and a mouthpiece, the other being somewhat thickened

Removing a Crucible from the Furnace

to receive the metal. The thickened end of the glass blower's tube is first heated to the temperature of the molten glass, after which it is dipped into the metal, turned slowly a few times and then removed. The small quantity of glass left sticking to the *nose* of the tube is allowed to cool until it is fairly stiff; the whole tube meanwhile is kept rotating so as to keep the little ball of the glass metal round. When this first *gathering* is cool enough, the end of the tube is again placed in the furnace and more glass collected. It takes great

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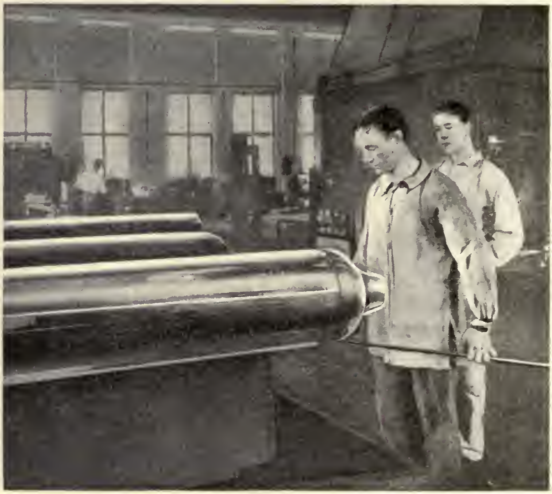
until an opening is finally blown out at the lower end of the cylinder. The glass cylinder is then laid on a wooden rack where the tube is removed by placing a piece of cold iron against the hot neck



Courtesy of the Philadelphia Commercial Museum

Cracking Off Window Glass Cylinders Preparatory to Flattening

of glass which is attached to the tube. This starts a crack in the glass and a quick jerk removes the tube. Then the neck of the cylinder and the uneven portion of the lower end are cracked off by passing a thread of hot glass around the cylinder and removing the thread as soon as it has cooled enough

to solidify. The cylinders are cut into sections in like manner.

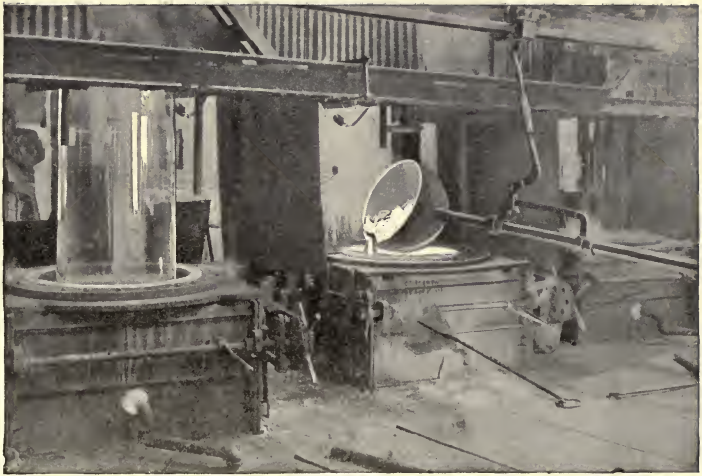
Most *window glass* is to-day blown by compressed air. Larger cylinders can be blown in this way and the glass is more uniform in thickness.

Before the glass cylinder can be flattened out it must be cut lengthwise. This is done, either by the application of a hot iron followed by slight moistening or by cutting with a diamond.

Cutting a Cylinder into Sections

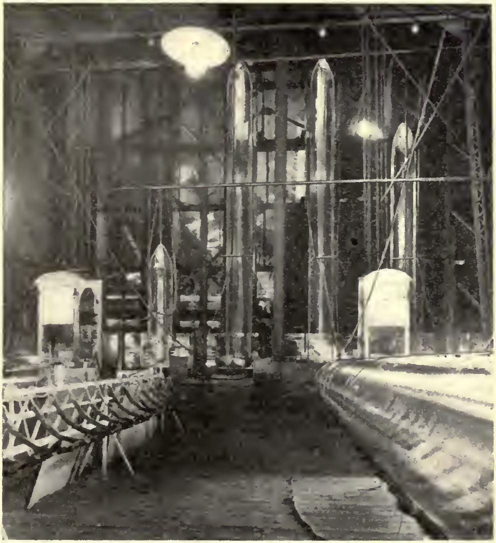
Annealing is the gradual heating and cooling of the glass to prevent brittleness. Two methods are used: the slow heating and cooling of the glass in a *kiln*, and the more rapid heating of it in an *annealing lehr* or oven through which the glass passes on a slowly moving carrier. The first method may require several days, while the second requires only a few hours. The rapid method is generally used in the annealing of ordinary window glass.

After the cylinder is split open it is taken to the lehr where it is placed in a chamber, the temperature of which is high enough to give the cylinder a dull red color. From this chamber it goes to another where the heat is such that it will soften



Pouring Metal for Blowing Window Glass Cylinders by Machine

the glass. Here it is laid on a smooth stone slab with the split edges up and slowly flattened out by means of a long wooden pole. It is then smoothed down by moving a wooden instrument

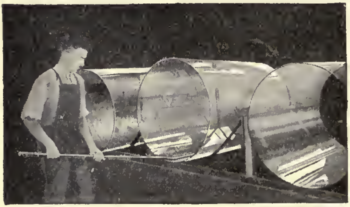


Blowing Window Glass Cylinders by Machine

lightly over the surface until the sheet lies perfectly flat. The cylinder has at last been transformed into a flat piece of window glass which now goes to still another annealing chamber which is of about the same temperature as that of the

flattening chamber. Here it is allowed to cool gradually after which it is taken to the sorting room and from there to the storeroom.

The process used in making *plate glass* such as is used in show cases and shop windows and in some houses is quite different from that used in making ordinary sheet glass. For plate glass, the materials used must be as pure as it is possible to have them and great care must be taken that the plate be as smooth and flat as possible so that a quantity of waste glass need not be ground away.

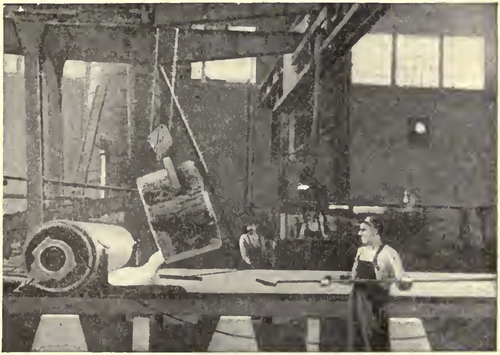


Cutting the Cylinders Lengthwise

The sand, soda ash, and lime are put into large crucibles made from fire clay, which can be placed in the furnace. When the materials have melted and mixed thoroughly, the crucible is lifted from the furnace by means of a powerful hoisting machine and moved to the roller table upon which the molten glass metal is poured. It is here rolled out to the desired thickness by a heavy iron roller which passes over it. When it has cooled sufficiently to be moved it is taken to the annealing chamber where it is sealed up and left for four or five days. A much longer time is required to

anneal plate glass than window glass because of the greater thickness of the material.

The next step is that of grinding and polishing. For these processes the large plate is placed on a revolving platform which moves on rails or tracks. It is first moved to the *grinding rubbers*. These are



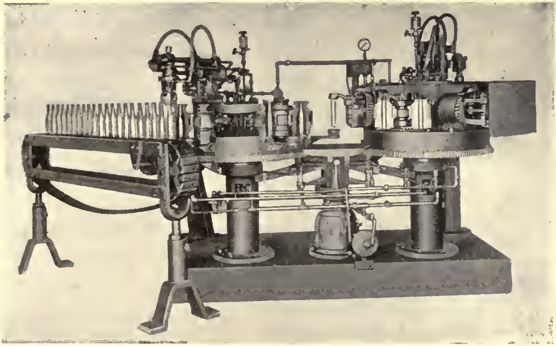
Rolling the Metal into Plate Glass

flat iron discs which work with much the same motion as when you rub the palms of your hands together by turning one palm against the other. The grinding material is sharp sand moistened with water. When most of the roughness is ground away, the grinding material is washed off and a finer sand used. This is continued until the surface of the glass is smooth, though the glass is still gray in color. The plate is then washed and

Polishing Plate Glass

A revolving platform is seen in the background at the left.

moved to another set of rubbers which are made of wood or iron and covered with felt pads. These, with the aid of rouge (finely powdered iron rust) moistened with water, polish it until it becomes the clear brilliant glass which we see in use.



MACHINE WHICH TURNS OUT 18 FINISHED GLASS BOTTLES A MINUTE

The *blank* mold at the right forms the head of the bottle; the body of the bottle is blown in the *blow* mold at the left and the finished bottles are carried off on the belt conveyer.

This final polishing process requires three hours or more. The glass is examined for defects, such as streaks or bubbles or dirt, and is then cut and the sheets sorted.

Cut glass is another product of the glass industry. The dish or vase which is to be decorated by cutting is made by pressing or by blowing the molten glass into the desired shape, using a mold of iron. The glass cutter cuts the decoration into the glass by press-

ing the dish or vase against a revolving grinding wheel which is fed with emery powder and water. The process of cutting is not always appropriate to glass forms and it often renders the forms unpleasant to handle. Cut glass dishes are weakened by the cutting and are more liable to crack when subjected to quick changes of temperature, as in washing, than are other glass dishes. Besides this method of ornamenting glass, beautiful designs are obtained by *staining* or painting and reheating, and by *etching* with hydrofluoric acid.

Will H. Low
ANGELS FROM STAINED GLASS WINDOW

Colored glass has ever occupied an important place in art. The Egyptians, the Phoenicians, the Greeks, and the Romans made free use of it as is shown by the many specimens of glass that have been dug up in their ancient tombs. The *Portland Vase*, which is now in the British Museum, will testify to the excellence of this historic glassware. The body of this wonderful old vase is dark blue. This body was covered with

a thick layer of glass of a lighter color which was then partially cut away leaving a design of great beauty.

The art of glassmaking seems to have been neglected during medieval times and utensils were made from wood or horn instead of from glass. However, about 1400 A. D., the art was again taken up by the Venetians, who were unsurpassed as glassmakers for many years.

Courtesy of the Metropolitan Museum of Art

Venetian Glass of the 16th and 17th Centuries

The great cathedrals built during the middle ages in Europe show evidence in their beautiful windows of a highly developed ability in making art glass. Among the finest windows of this period are those of Liége in Belgium, Gouda in Holland and King's College Chapel, Cambridge, England.

The following is a list of modern products commonly made of glass:

(a) Blown glass		(b) Pressed glass
window glass	cut glass	utensils
bottles	stained glass	insulators
bulbs	jars	(c) Plate glass
		mirrors
		wire glass

(d) Beads

Modern stained glass is equal if not superior to that produced earlier and nowhere is finer glass produced than in the United States where the art of making stained glass for church windows has kept pace with the art of making beautiful glass utensils. Tiffany glass made in the United States is perhaps the finest colored glass produced, both from the standpoint of brilliancy of color and variety of texture. Many pieces of this glass utilize the best of the experience of all periods.

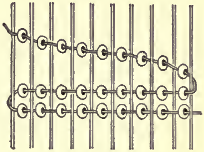
The bead maker's art has never been thoroughly Americanized. Our best glass beads still come from abroad. This does not signify that American manufacturers cannot make beautiful glass beads. They have demonstrated that they can make them. But they cannot compete with the countries on the other side of the Atlantic where people work for a lower wage.

Beads are used in the making of chains and necklaces and as decorations for textiles. They are applied to fabrics by embroidery and in the weaving. Bead embroidery is much like common embroidery which consists in sewing strands of thread to the surface of the cloth. In bead weaving the beads are strung upon the weft strand.

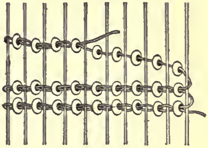
The three most important types of bead weaving are illustrated on page 283. They are as follows:

(a) *Single weft.* After the warp threads are stretched, a single thread with needle is passed through.

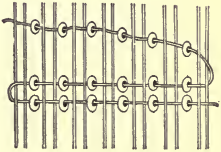
(b) *Double weft.* In this the weft thread is passed through the beads and then beads and thread are laid upon the warp after which the needle is passed back through each bead on the other side of the warp threads.


Single Weft

(c) *Double warp.* Here the warp is often manipulated by a harness frame. (See Chapter VII, page 194.) The weft thread is strung with the correct number of beads and then passed between the warp threads. In this way the beads are properly spaced.


Double Weft

The American Indians were and still are master bead weavers. Their real bead work originated with the introduction of glass beads into America by the first white settlers although prior to 1500 they had worked on buckskin and cloth, using quills instead of beads. Beads were regarded as a great improvement over the quills.


Double Warp

Bead weaving is to-day becoming even more popular than ever as a means of making beautiful fabrics which are fashioned into bags, purses and

many other articles of artistic merit which are often of great commercial value. Bead woven fabrics are strong and durable.

Glass Bead Work

Bead construction offers opportunity for counting, repeating decorative units, and creating good color combinations. The simple stringing of beads includes repeating in alternation the same number of beads in two colors, various numbers of beads in two colors, and various numbers in three or more colors. By looping the chain at given points you will discover a variety of additional effects. Bead necklaces form an excellent introduction to the study of jewelry. Various methods of stringing beads are illustrated on page 286 and described below:

Old Indian Weaving Bow Used in Primitive Bead Work

A. A simple chain is started by tying on the first bead (this, in bead work, proves inevitable); a single dark bead is followed by a single light one. Leave the beads rather loose, return from a dark bead, string on a light one, through the dark, and on a light one, until completed. Any number of beads may occur between those taken up. This may easily be developed into a bag or purse, which may be made with or without a silk lining. Our

grandmothers made exquisite collars in this way, carefully shaping them by count.

B. The chain is worked with two needles, threaded on both ends of a silk or cotton thread. Wax the thread. When a link is completed instead

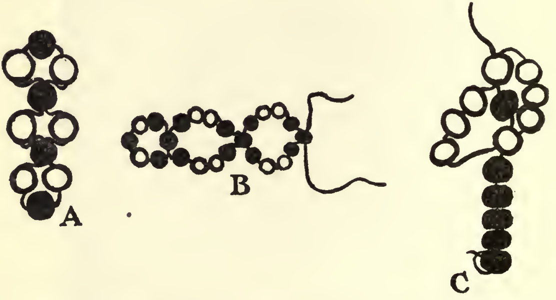
The Modern Priscilla

Triple Bead Chain of Forget-me-nots

of entering the bead from the same direction in which it was strung, let the second needle enter the bead from the opposite direction and the needles will cross the thread in the middle of the bead. A variety of designs is possible.

C. With a single string of beads we sometimes wish to carry a straight line and to vary it with a flower effect. The daisy or the forget-me-not form

has been especially successful. After making the straight line by stringing a certain number of beads (in this case five), string on eight white beads, carry your needle and thread through the first white one in the same direction it was strung. Take up one yellow bead for the center, pass the needle through the fifth, or opposite bead, and string the other color again.



There are several other ways of constructing flower patterns. Experiment with two or three strong threads. Cotton, black and white, and ordinary sewing silk are good materials to use for stringing. It is desirable always to wax the thread. With one strand, an occasional knot made in the thread will enable the beads to lie loose and this also lightens the strain on the thread. Fringes of beads should never have their threads cut at the bottom. Return the thread a second time up through the beads to the heading. A loop, or a

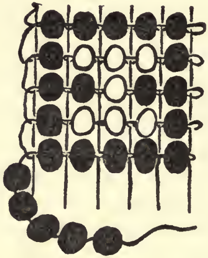
daisy, or a larger bead may uniformly or occasionally finish the ends of the fringe.

D. The simplest method of design, and, perhaps, of construction also, in all-over surface patterns, is to stretch the warp or vertical threads on a pasteboard frame or on a simple wooden loom. On the pasteboard the threads may exactly fit the dimensions of the piece of work when finished. If a loom is used, the cut ends of the warp will have to be fastened at either end. Make your design first on the squared paper, letting the vertical lines represent the warp threads which lie between the beads. These threads will probably be heavier than the thread with which you sew the beads, but this will make no difference.

In stringing the beads, tie the sewing thread, well waxed, to the first warp strand. String the beads called for by your design in sequence, from left to right. Carry the weft thread under the warp thread, stringing a bead between every two strands, and so on across the loom. Bring the thread over the right warp end and pass the needle back through each of the beads in succession. Each warp thread will be crossed by two weft threads, one above and one below, held in place by the beads.

Chains of four or five beads in width, with repeats of small units, are attractive and useful for many purposes. Purses, cardcases, candle and lamp shades, may be made by this method, as well as belts and chains.

E. The same directions for design may be applied to free weaving without a loom. String the first row of beads from left to right, tying the first bead on at the left. The design might have an odd or even number of spaces across, but an even number is more satisfactory. String on the first right bead on the second row, carry thread through the next to the last bead on the previous row; string a bead, carry thread through below



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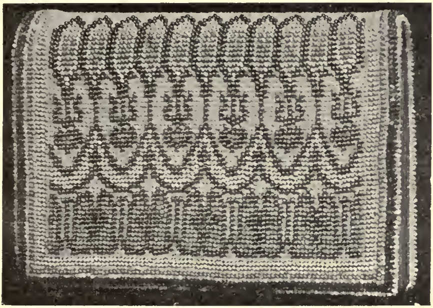
E

and with an even number the needle will hold the first bead before returning to fill in the second row. One thread carries straight and the other alternates between two rows. Extra beads may be added on the edge for picot finish. Always make your design first on the squared paper. There are no ends of thread to be considered, as in the warp strands above. After a center has been constructed, a border may be worked, carrying thread and stitches all the way round. Fine wire may be used instead of thread in this construction.

Similar to the last in construction, but different in design, is diagonal free sewing. No loom is used. In the design the squared paper is turned diagonally.

Little flowers may be scattered through the chain design in many different ways, and patterns of single units of beads may be tastefully distributed over a background of silk or canvas.



The Modern Priscilla

Beaded Cardcase

For all-over beadwork on canvas, the waxed thread should be worked the reverse of ordinary cross-stitch on canvas. On the upper or bead surface carry the thread straight, vertically or horizontally, according to the best effect for the colors used. Underneath, let the stitch slant diagonally. If you cannot keep the direction uniform when you work over and back, fasten the thread each time and work always from left to

The Modern Priscilla

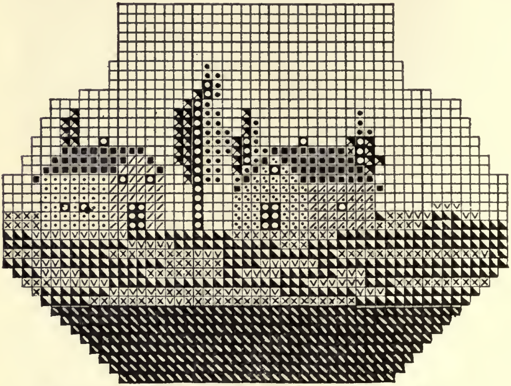
Hand Bag of Gold, Steel, and Crystal Beads on Canvas

right, or from right to left. If the beads are so irregular that the canvas shows through in spots, you can stain the canvas with dyes or with strong water color from the back. Brilliant colored sewing silk varies the color effects if transparent glass beads are used.

Leather makes a very satisfactory background. It is most successful and interesting in its application in stripes or bands of five beads in width. The spacings between the stripes are decidedly effective. Sometimes only one color of beads is used (in this case, blue seems to be a favorite). Where narrow bands edge moccasins, bags, and belts of Indian design, simple patterns are most effective. The silk for sewing should be waxed. It need not go through the leather or show on the other side.

When you prefer to fill a space solidly make your design carefully on paper which has been marked off in very small squares and use a very strong fabric or leather as a foundation. Stretch your thread from the left, where it has been fastened; string on the beads following your design, in sequence from left to right, first row. Pass your needle into the fabric on the right. Do not crowd the beads too close together. Bring your needle through the fabric under not more than five beads at a time, then to the surface; carry it through a few beads and again under the next group through the fabric. String each row from the left and

fasten on the return from the right. There should be no break in the line or surface of the beads; all should lie perfectly smooth and even. Large



1—Light Green, glass
1—Brown, glass
• 1—White, opaque
/ 1—Yellow, opaque
1—Black
2—Dark Amethyst

× 1—Dark Green, opaque
1—Dark Rose, glass
1—Medium Green, opaque
V 1—Light Green, opaque
● 1—Dark Green, glass
1—Medium Blue
4—Opal

The Modern Priscilla

Design for Beaded Bag Drawn on Squared Paper

Symbols are employed in the design to indicate the color of beads to be used.

medallions or designs with a rich variety of color can thus be effectively worked on leather bags.

In designs on leather the effect is often better when the direction of the strings of beads varies.

This time make your design freely, without squared paper and then transfer the design to the fabric. String the outer line of beads. Fasten them, as before, running the thread under the fabric and then up through the beads. Place row next row as the design requires.

Sometimes in all-over design, the border or special parts may be worked in a different direction from that of the background or other parts. This does not imply that the worker may be careless; it requires increased thoughtfulness and care.

My Work

Let me but do my work from day to day,
In field or forest, at the desk or loom,
In roaring market-place or tranquil room;
Let me but find it in my heart to say,
When vagrant wishes beckon me astray:
"This is my work; my blessing, not my doom;
Of all who live, I am the one by whom
This work can best be done in the right way."
Then shall I see it not too great, nor small,
To suit my spirit and to prove my powers;
Then shall I cheerful greet the laboring hours,
And cheerful turn, when the long shadows fall
At eventide, to play and love and rest
Because I know for me my work is best.

Henry Van Dyke

Exercises for Study and Review

(1) For what purpose was glass first made?

(2) What use did the American Indians find for glass?

(3) What are the three materials most commonly used in glass making?

(4) Compare the making of glass with glaze making in a pottery.

(5) How can you tell ordinary window glass from plate glass? If you cannot answer this question at once, compare the glass commonly used in windows with the glass used in the large show windows of stores.

(6) How is common window glass made?

(7) How is plate glass made?

(8) Explain Charles F. Ulrich's picture, "Glass Blowers of Murano."

(9) Why are utensils impractical when made of cut glass which is cut too deeply?

(10) Which would you prefer to be, a salesman of chinaware or of glassware? Why?

(11) In what kinds of glass products does America excel?

Suggested Reading about Glass

Bassett.—*The Story of Glass.* Penn Publishing Company.

Chamberlain.—*How We Are Sheltered* (Page 146, *Glass*). The Macmillan Company.

Eppendorff.—*Handwork Construction* (See *Beadwork*). Pratt Institute.

Lethaby.—*The Artistic Crafts Series* (See *Stained Glass*). D. Appleton & Co.

Rocheleau.—*Great American Industries* (Page 37). A. Flanagan Co.

Rodgers and Others.—*Trade Foundations* (Index under *Glass, Glassware*). G. M. Jones, Indianapolis.

Tarr and McMurry.—*New Geographies*, Second Book (Index under *Glass Making, Mosaic Work*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials*. Ginn & Co.

Wells.—*How the Present Came from the Past*, Book Two (Index under *Glass, Glass Blowers, Magnifying Glasses, Mirrors, Opaque Glass, Vases*). The Macmillan Company.

Williams.—*How It Is Made* (Chapter VIII). Thomas Nelson and Sons.

Andrew Brakken

LOGGING

XII

WOOD AND WOODWORKING

Most of the people in the world to-day are dependent upon lumber or other wood products for shelter and for many necessary commodities. It would not be a difficult matter to list a hundred articles that we all use every day, some part of which is made from wood. Realizing the importance of this material in our daily lives, let us investigate its transformation from tree to finished product. The first stage of this transformation is *lumbering*.

When lumbering is engaged in upon a large scale, a small group of men is first sent into the forest on a *land-looking* trip. They inspect the various parts of the forest in search of the best timber, and they try to determine the most economical way of transporting it to market. A suitable site for operations is chosen and the location of the *main camp* is decided upon. To mark off the timber tract definitely, it is customary to bound it by *blazing* or gashing certain trees which will

Photograph by Lindley Eddy

California Redwoods

serve as markers. The foreman of the company operating on the land usually hires all the men needed to do the work. The list includes lumberjacks, cooks, clerks, and a blacksmith. A complete outfit is finally gotten together which includes teams, wagons, saws and other lumber working tools, stoves and cooking utensils, a blacksmith's outfit, and a stock of supplies sufficient to last for several months. These goods are hauled in over a rough *tote road* cut through the forest to the main camp site. The men are now set to work building the bunk-house, office, blacksmith shop, mess house, and stables. Not until these buildings are finished and everything is in place does the real work of lumbering begin.

The first great task in the lumbering operations is the building of a wide, smooth road which extends from the heart of the forest to a place from whence the logs can be transported readily, either by rail or by water. The road must be carefully built in order that it may withstand the enormous weight of the loads of logs which must pass over it. Every stump and rock is removed, the roadbed is plowed and packed, strong bridges are built, and everything is put in first-class condition. Wherever needed, *skidways* are provided at the side of the main road. These are merely cleared areas upon which logs may be temporarily stacked before the hauling begins. From each skidway narrow *dray roads* must be chopped back through

the forest so that the logs may be dragged out by the teams to the main road.

The second part of the lumbering operations consists in *felling* the trees and trimming the logs. Preliminary to the felling, however, a *fitter* goes through the woods and designates each tree to be felled by means of an axe gash on the side toward which it is to fall. The *sawyers* then enter the woods in pairs. When they begin to fell a tree they first chop a deep notch in it on the side toward which it is to fall. Then with a thin, flexible *crosscut saw* they begin to cut the tree off, starting on the side opposite the gash. When partly sawn the tree will settle down, closing the *kerf*, or opening made by the saw, and pinching the saw. This is remedied by driving, with a large wooden maul, an iron wedge into the kerf. The sawing and wedging are continued until the tree is nearly cut off. If it does not now fall of its own accord more wedges are driven in, until it is finally thrown in the proper direction.

A great amount of judgment and skill must be exercised in felling a tree to avoid serious accidents and to keep the tree from lodging in the branches of others near by. Very heavy trees must not be allowed to fall across stumps or hard ground lest their trunks be split from the impact. Sometimes brush is piled upon the ground to make a falling bed for a large, valuable tree. In hilly countries trees are thrown uphill to shorten the falling distance.

When a tree has fallen, the sawyers pass on to other trees while *swampers* trim off the branches close to the trunk and cut the tree into standard log lengths, exercising the utmost care to avoid the knots and irregular or rotten parts.

The third stage consists of dragging the logs

Cress-Dale Photo Co.

HAULING A TWENTY-FOOT SPRUCE LOG ON MOTOR TRUCK

The log was about 4 feet in diameter, and contained 3,000 feet of lumber. This operation was a part of the U. S. Army Airplane spruce production operations, where the spruce timber was too scattered for rail hauling.

to the skidways where they are to be piled. Generally a man does the skidding with a team of horses, hitching to the logs by chains or with tong-like hooks, and *snaking* them to the skidways. Here the logs are placed crosswise on two

Charles S. Chapman *Courtesy of Scribner's Magazine*

SLOOPING LOGS DOWN THE MOUNTAIN

skids or small logs laid about ten feet apart and at right angles to the main road. Since many logs must be placed on one another they are *decked* on the pile by means of a horse hitched to a log chain that is fastened to the pile of logs

U. S. Forest Service

Skidway on Big Blackfoot Timber Sale, Montana

and extends out under the log that is being decked and back over the top of all, to the horse on the other side. These logs lie on the skidways, while others are being cut and piled, until winter sets in and enough snow comes to prepare for the sleigh haul.

Logs are often *slooped* down the mountain side to the lakes or rivers. The *sloop* used for this purpose is a rough sled made of two kinds of wood, a hard wood and a stout, supple wood;

from the latter the runner facings are made. The facings are fastened to the runners by means of wooden pegs. The ends of two big logs are usually chained to the sloop while the opposite ends are allowed to drag on the road to act as a brake. The little French Canadian horses used for this purpose are often very expert. On the very steep places they must sit on their haunches and slide ahead of the heavy logs, but the moment the lake is reached they must swing to one side out of the way of the load.

When the logs are all on the skidways, two *scalers* work at the log piles, one at each end, measuring the logs to determine the number of feet of lumber in them and marking them with the company's name by means of an iron stamp made with a handle and used like a hammer.

As soon as the cutting, skidding, and scaling of the logs is accomplished the men turn their attention to preparing for the hauling to the shipping point. They go over the main road again and repair any irregularities in its surface. The surface of the road is flooded with water in freezing weather by means of immense road sprinklers. After repeated sprinklings the road becomes a hard and smooth bed of ice.

Heavy sleds are now drawn to the skidways and are carefully loaded with huge piles of logs. The method of loading is the same as that employed in decking the logs on the skidways. When the

sled is loaded and the logs have been securely chained and clamped in place, a single team of horses is hitched to the sled to pull it to the shipping point. The horses must have very sharp shoes to enable them to pull on the icy road; on account of the smoothness and slope of the road they do not have to pull very much, but rather to guide and check the rush of the load, especially on the steep places. The drivers of these immense loads must be skilled horsemen, for if the load once gets away, or leaves the road, the driver as well as the team may be killed.

When the load reaches the shipping point it is stopped opposite two skids which with others reach to the railway cars, or to the river, as the case may be. The load is now unchained and the logs allowed to roll off the sled and upon the skidways. They are now, by means of a horse and chain, either loaded directly on cars and shipped, or else they are rolled out upon the ice which at this time covers the river. The hauling continues until every log has been shipped, or decked on the ice of the river. In the latter case, nothing more can be done until the spring thaw releases them.

When the ice begins to thaw and the freshets to fill the river, the *lumberjacks* don their waterproof suits and heavily spiked shoes. Then, each with a *peavey* (a sort of *cant hook* and *pike pole* combined which is used to roll and propel the logs) they set to work. When the ice and logs

start to move, some of the men have to *ride* the logs to help prevent *jams*, while others work along the shore to keep the logs from landing and also to start those which have become lodged. The men must be skillful in handling the logs to keep them

U. S. Forest Service

Men Riding Logs down Stream, Northern Michigan

moving. Sometimes, in spite of their efforts, the whole mass becomes wedged and forms a *jam*. On account of the great pressure of the water and of the logs behind, it is almost impossible to start the mass moving without the aid of dynamite blasts to break the *key* logs or those which are doing the holding. Log jams have been successfully broken by damming the stream above the

jam so that when the dam is removed the large volume of water released will sweep the logs upward and forward. The *drive* continues until the logs reach the mill where they are to be sawed.

U. S. Forest Service

Logs from Pond Passing up Slip of Mill at South Gardiner, Maine

Here a heavy fence of logs is stretched across the stream to stop them as they come down the river and to guide them to the mill pond where they are allowed to float until they are finally sawn into lumber.

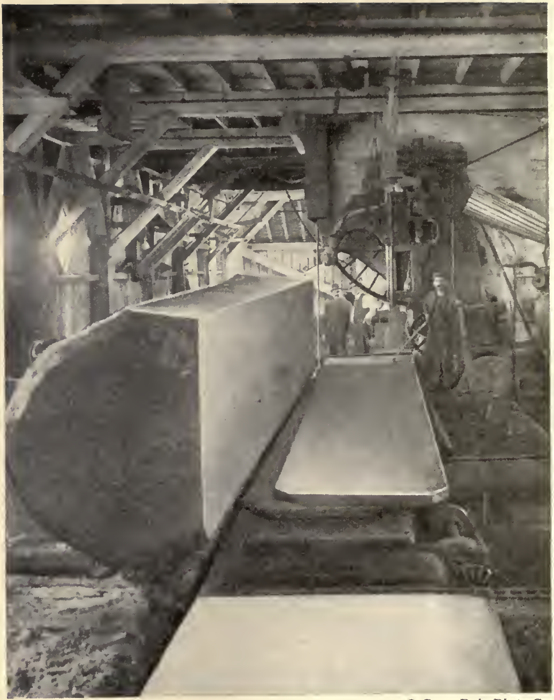
The logs are allowed to remain in the water as long as possible as this prevents *checking*, or crack-

ing due to contraction in drying. One by one they are pulled out of the water and guided to the end of a long sloping *jackladder*, a trough in the bottom of which there runs an endless chain provided with *dogs*, or hooks, which prevent the lower ends of the logs from slipping. The process of *sawmilling* begins when the logs climb the jackladder. They move almost end to end. After reaching the floor above they are rolled off sidewise on a sorting platform where they are hastily examined for stones or other hard substances which might injure the saw.

When the logs have been inspected they are rolled down an inclined platform until they are stopped near the *saw carriage* by an automatic *log stopper*, which is worked by a steam piston. It allows but one log at a time to roll upon the carriage.

As soon as the log is on the carriage it is clamped securely in place. Then the carriage is driven forward against the saw and a thick slab of bark is cut from one of its sides the entire length of the log while the carriage passes by the saw and on to the opposite end of the track. Here the log is turned halfway over either by hand with a cant hook or by a toothed arm driven by a steam piston.

The carriage is now reversed and as it passes by the saw on its return trip a second slab is cut off. The two cuts already made are at right angles to one another. Similar slabs are now sawn in



© *Cress-Dale Photo Co.*

INTERIOR OF A TYPICAL SAW MILL

A six-foot spruce log is on the carriage. The band saw is 16 inches wide and 50 feet long and is held at a tension of 5,000 lbs. The man with the pickaroon, a sort of cant hook, is the off-bearer, who takes the slab as it comes from the saw and drops it to the rolls; the sawyer and the mill foreman are in the back-ground.

like manner from the two uncut sides as the log again passes the saw on its trip to the opposite end of the track and back.

If the timber is to be left square it is now removed from the carriage, but if it is to be cut into boards the sawyer goes on cutting off boards by moving the log a little farther toward the saw after each board has been cut off. As the timbers leave the saw they are taken directly to the other machines on *rollers* which are kept turning by machinery. When the boards have reached their destination they are removed by chains which travel at right angles to the direction in which they were moving.

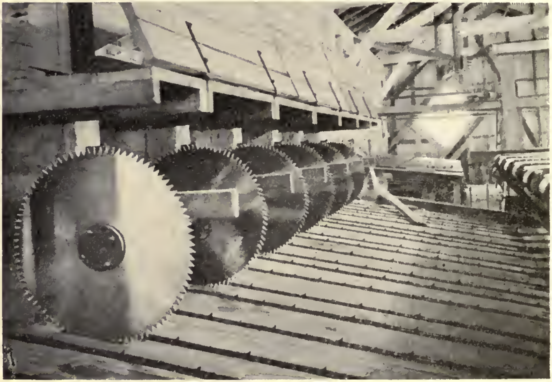
The first boards cut sometimes leave the saw with rough bark along their edges. These must pass between a pair of *edger saws* which trim off the bark from both edges at the same time cutting all these outside boards to the same uniform width.

These boards, along with the others, now pass through a *lumber trimmer* which cuts them all, approximately, to the same length.

The lumber goes next to the sorting room where it is graded as to quality and cut to exact length by a *swing cut-off saw*.

The slabs first cut from the log are now cut into shingles or lath. They are cut automatically into suitable lengths by the *slasher saw*. Another machine rips them, counts and binds the shingles

and laths into bundles of standard size. The small chips and sawdust from these machines are blown through pipes to the furnace room where they are used for fuel. Large chips and worthless boards pass through the *hog*, a machine which chews them into fine chips, also used for fuel.



U. S. Forest Service

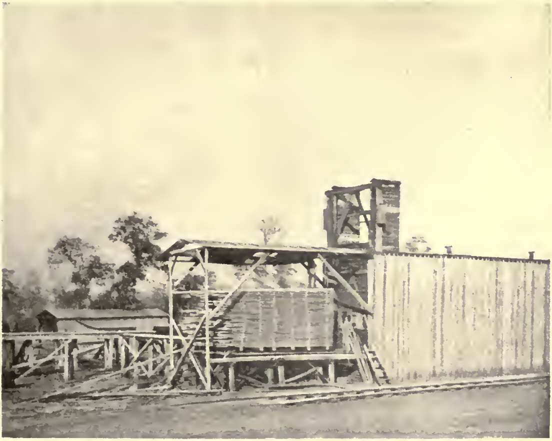
Slasher and Trimmer at Government Saw Mill, Menominee, Wisconsin, Indian Reservation

In this way there is no waste at all, as the unmarketable part of the wood is used to furnish motive power for the mill.

You will recall that in the winter after the logs had been cut they were dumped into the river and allowed to lie in the water for a long time, and that they were left in the mill pond until

just before the sawing. The logger does not leave the log in the water because this happens to be convenient but rather because this soaking is necessary in the *curing* process.

Lumber is generally piled in a large lumber

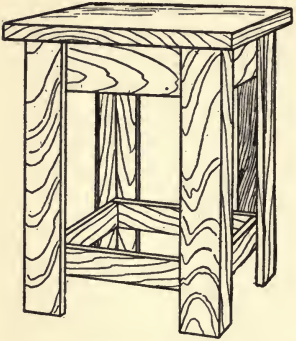


U. S. Forest Service

A Pile of Lumber Ready to Be Placed in the Dry Kiln; De Funiak, Florida

yard, the boards being placed one upon another with slats between them to allow for the passage of air. A roof formed from rough lumber is constructed over the pile. This keeps the boards from checking (cracking) by protecting them from the direct rays of the sun and from the soaking rain.

The weight of the pile prevents the boards from warping. In this way the lumber may remain until it is properly cured. If the lumber is to be used for rough work only, a short period of *seasoning* is sufficient. For fine work however, it is allowed to remain undisturbed for five years or more. This method of seasoning was the most common until recent years. Modern manufacturing methods, however, have found it impractical to allow so much time for seasoning. As a result *kiln drying* has become popular inasmuch as this method of hot air seasoning requires but two weeks. Open air drying is still regarded by most manufacturers to be superior to kiln drying although more of the moisture is removed by the kiln than in the open air.



I

How to Make a Small Table

This table is a low stand intended to hold a potted plant. It might also be used to hold a small phonograph. It is made of ½ inch stock, with the exception of the top which is of ⅞ inch

stock. Chestnut is recommended for the purpose inasmuch as this wood is soft and nicely grained. There are no complicated joints of construction such as are found in many tables of this kind. Each leg is made of two pieces of ½ inch stock glued and nailed, and the *rails* or horizontal parts are fastened to the inside of the legs by screws. The top is attached with four small *angle irons* and screws.

MATERIALS

2 pieces of chestnut ½ in. x 8½ in. x 1 ft. 2½ in. for the legs.
1 piece of chestnut ½ in. x 9½ in. x 1 ft. 5 in. for the rails.
1 piece of chestnut ⅞ in. x 11⅝ in. x 11⅝ in. for the top.
20—1¼ in. No. 16 wire brads.
20—⅞ in. No. 8 flat head bright wood screws.
8—½ in. No. 8 flat head bright wood screws.
4—1 in. No. 8 flat head bright wood screws.
4—1 in. angle irons.
1 sheet of No. 1 sandpaper.
Glue and putty.

TOOLS

Plane, try-square, rule, knife, gauge, ripsaw, hammer, crosscut saw, nail set, No. 6 gimlet bit and brace, countersink, screwdriver.

MAKING THE LEGS

(1) The material for the legs is already of the correct thickness, ½ inch and also of the correct

length, 14½ inches. One piece in each leg is 2 inches wide, and the other piece 1½ inches wide. When these two boards are joined the wider piece will cover the thickness of the narrower and, measuring from the square corner of the leg in both directions, the width will be 2 inches. In order to make a good joint the edges must be exactly *straight* and *square*.

(2) On one of the two pieces 8½ in. x 1 ft. 2½ in. from which the legs are to be cut, *plane* an edge which will be square with one face, and mark it with an X. This edge will be the *working edge*. Use the *try-square* in testing for squareness.

(3) From the working edge *gage** 4¼ inches, marking all around the stock. This width will be sufficient to provide for the material needed in making one leg.

(4) Cut the board lengthwise, sawing exactly on the gaged line. We now have ready the stock for two of the legs.

(5) Repeat these operations in preparing the second piece of stock, 8½ in. x 1 ft. 2½ in. When this is done we shall have prepared four pieces 4¼ in. (minus the waste from the saw) x 1 ft. 2½ in., providing one piece of stock for each of the four legs.

(6) Two of the pieces of stock are already supplied with a working edge. Provide working edges

* The gauge is a tool used to draw lines parallel to a working edge or face. If no gauge is at hand you may use your knife or pencil.

for the other two boards by planing one edge of each. (It is best in each case to plane the straighter edge.) Mark the working edges with an X as before. We now have four pieces each bearing properly marked working edges.

(7) Gage upon each of these four pieces of stock 2 inches, the width of the wider board for each leg. Gage entirely around as before.

(8) Cut each of the four boards in two, sawing just outside the gaged line.

(9) Plane carefully the rough edge of each of the 2 inch (wide) pieces of stock bearing the working edge. These boards are now finished.

(10) Let us now plane a working edge on each of the four remaining pieces, marking it with an X and gaging 1½ inches from the working edge and planing down to the gage line. The narrower boards are now complete and ready for *assembling* or putting together.

ASSEMBLING THE LEGS

(11) Each leg is formed by fastening a piece of wood ½ in. x 2 in. x 1 ft. 2½ in. to a piece ½ in. x 1½ in. x 1 ft. 2½ in. so as to form a right angle which will measure 2 inches from the outside corner to each opposite edge. To assemble the parts of a leg start five 1¼ inch brads into the face of one of the wider pieces, ¼ inch from one edge using a *hammer*. Start one brad 1 inch from each end and space the others evenly between. How far apart will the brads have to be?

(12) Place one of the narrower pieces of wood on edge on the desk or in a vise if you have one, and spread glue thinly along its edge where the two pieces are to be joined.

(13) Put the wider strip exactly in place on the narrower strip and start the brads into the narrower piece, using the hammer.

Make sure that the parts will fit before you drive the brads.

(14) Examine the work carefully to see that all nails are being driven straight. If any are crooked remove them and start them in new holes, not in the original ones. It is impossible to change the direction of a nail after it has been driven halfway through the stock.

(15) Finish driving the nails.

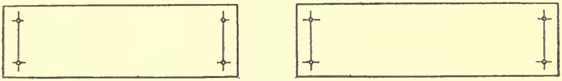
(16) In like manner assemble all the legs.

(17) To finish the legs, drive the brads $\frac{1}{16}$ inch below the surface with the hammer and *nail set*. After this is done it is possible to *dress* off a thin shaving from the outside surface of each leg. Hold the work in the vise if you have one and take off as little of the wood as possible. Plane with the grain of the wood. Fill the nail holes with putty or filler, and sand the outside surface and edges of all four legs. This will give the work a smooth appearance and will prepare it to receive the *finish*.

MAKING THE RAILS

(18) The rails are made from the piece of stock 9½ in. x 1 ft. 5 in., which is already of the correct length and thickness. Four strips are necessary, two 2½ inches wide and two 1½ inches wide. These are later to be sawed in two, but do not do this until directed.

(19) First make both the 2½ inch pieces, then the two 1½ inch pieces. Follow the method used



The Location of Screw Holes in the Wide Rails

The Location of Screw Holes in the Narrow Rails

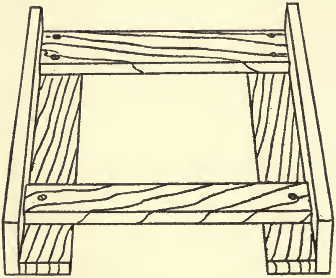
for cutting the leg pieces, but observe the difference in dimensions. Use the try-square in testing the edges.

(20) The rails are to be of two lengths, 8 inches and 9 inches. Measure 8 inches from one end of each strip, and draw a pencil line through the measurements with the try-square handle against the working edge X. The length from this measurement to the other end of the strip should be just 9 inches, the correct length for the other rail.

(21) Cut on the pencil line. When finished, you should have two wide rails and two narrow

rails approximately 8 inches long and a similar set approximately 9 inches long.

(22) There are to be four screw holes in each wide rail, two in each end. Draw pencil lines across the piece ½ inch from each end. Measure on these lines ½ inch from the working edge and the same distance from the other edge. (See page 318.)


Two Legs Held in Place by the Long Rails

(23) Mark all four wide rails in this manner. Hold the pieces in the vise and bore on these marks with the No. 6 *gimlet-bit* or ⅛ in. *drill* used in a *brace.*

(24) There are to be two screw holes in each narrow rail, one in each end. Draw a center line lengthwise of the piece, and measure ½ inch from each end and place a point. Bore a hole at each point.

(25) All these holes must be *countersunk** on the back of each piece. Examine the rails and mark the poorest surface, to be used as the back. Then countersink the screw holes with the countersink used in the brace, to fit the heads of ⅞ inch

*Countersinking consists in enlarging at its opening a hole to receive the head of a flat-headed screw that the head may be even or *flush* with the surface of the stock.

No. 8 flat head screws. Try a screw in one of the holes to be sure it has been countersunk correctly.

ASSEMBLING THE LEGS AND RAILS

(26) Lay two of the legs on the bench with the boards 1½ inches wide, underneath. Place two of the 9 inch rails in position between them, a wide rail at the top end and a narrow rail 2 inches from the bottom end. (See page 318.)

(27) Use the ⅞ inch screws and start them in the drilled holes with a hammer. Soap may be used to lubricate them. Hold the ends of the rails firmly in the angles of the legs and, with the *screwdriver*, drive the screws in securely. Put these legs aside.

(28) Join the other two legs by the other two long rails, in exactly the same way.

(29) Connect the two pairs of legs by means of the four remaining rails, the wide ones at the top, the narrow ones 2 inches from the bottom. In this work use a screwdriver with a short handle, if you have one. Drive the screws in securely.

MAKING THE TOP

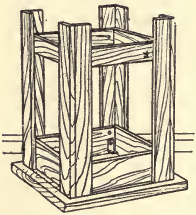
(30) The top is to be ⅞ of an inch thick and 11½ inches square. Plane the working edge; mark the length 11½ inches, and plane the end. Mark the width 11½ inches, and plane the opposite edge. Plane the other end.

(31) Sand the entire top, rubbing with the grain of the wood.

ASSEMBLING THE FRAME AND TOP

(32) Place the table top on the floor with the better side down. To locate the position of the frame draw a square on the top, the sides of which are ¾ inches from the edges of the square top.

(33) Place the inverted frame in position on the table top exactly within the square just drawn and put ½ inch screws through the angle irons, first into the rails and then into the table top. (See illustration.)



Fastening the Top to the Rails

SANDING

(34) Go over the surface of the table with sandpaper wherever this is required. Remove all sharp edges with the sandpaper held in the hand, not on a block of wood.

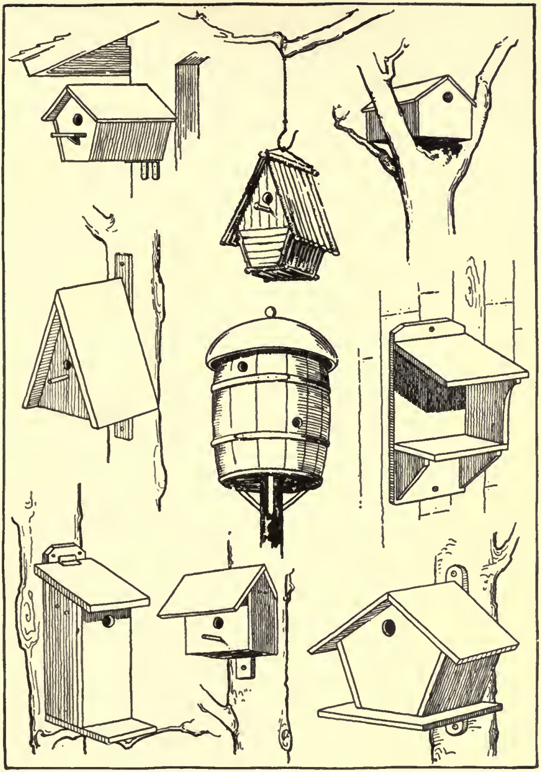
FINISHING

(35) Finish with stain and wax or with stain and shellac (rubbed) finish. If you prefer you may choose a stain colored to harmonize with surroundings in the room where the table is to be used.

II

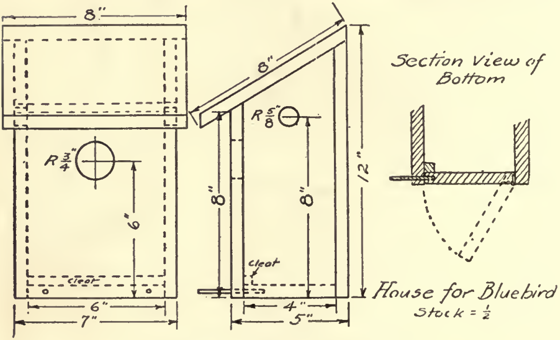
How to Build Bird Houses

There are three types of bird buildings: the nest shelter, the food shelter, and the nest house. The nest shelter is open on one or more sides and its walls and roof merely afford protection from



Suggested Designs for Nest Houses and Food Shelter

wind and rain. The food shelter is a roofed structure, open on the sides, with a floor space for crumbs, seeds, and other food. The nest house is a small building in which the birds may rear their young. The house may be constructed with floors and partitions to accommodate a number



Working Drawing of a Bird House

of families or it may be made small for a single family. The following requirements are essential:

(1) Ventilation through holes near the top and above the entrance opening.

(2) Ready access for the hand of the landlord for cleaning—through the side, the bottom, or the top. The working drawing shows how the bottom may be *hinged* to swing downward, thus allowing a thorough cleaning of the interior to be made.

(3) Proper protection from rain. The front should face away from prevailing winds.

(4) Entrance openings nearer the roof than the floor; otherwise the bird would have difficulty in constructing the nest.

Wood is the best material for bird houses. Earthenware and metal are likely to become overheated from the sun's rays unless the house is well protected. Some pupils have used concrete successfully in the construction of bird houses.

In wooden houses, nails and screws should be set or countersunk deeply and the heads of the brads or screws covered with putty.

Paint adds to the appearance and durability of bird houses. If in trees, green, brown or gray houses will harmonize with the foliage. Experiments have been made with dull-colored and bright-colored houses and it was found that the color made no difference to the birds. Excellent opportunity is, therefore, offered for decorative effects in bright colors, such as red roofs, white sides and green shutters.

Entrance openings vary with the size of the bird tenants. Usually they are made too large. The following sizes have been found satisfactory and are taken from *Farmers' Bulletin 609*, United States Department of Agriculture, on "Bird Houses and How to Build Them."

House finch, crested fly catcher, red-headed woodpecker,—2 inches.

Blue bird, tree swallow, hairy woodpecker,—1½ inches.

Tufted titmouse, white-breasted nuthatch, downy woodpecker,—1¼ inches.

Chickadee, Carolina wren,—1⅛ inches.

House wren,—⅞ of an inch.

Robin, barn swallow, phoebe—one or more sides open.

Wood for constructing houses should not be too thin. One-fourth inch stock is likely to warp. Three-eighths of an inch thick or even thicker should be used. When the houses have pointed roofs, a strip of thin brass, copper, or painted sheet iron should be nailed on the top, or *ridge* to cover the joint so that water cannot work its way through.

Before making the entrance hole, the kinds of birds which frequent the premises should be determined. Then their haunts and social habits should be discovered. A careful record of these things should be kept in a nature study notebook. Finally the house or houses should be stationed in places suggested in your notebook. A close watch should be kept and such events as the first bird to perch on the house, the first entrance, the kinds of material carried in, etc., should be carefully recorded in the nature study notebook.

Some of the sketches in the illustrations are of houses actually made by pupils in school. The large cylindric house was made from a small nail keg with the addition of an inverted wooden chopping bowl. A floor was placed halfway between

the top and bottom of this house to allow space for two families.

Stradivarius

"Antonio Stradivari has an eye
That winces at false work and loves the true,
With hand and arm that play upon the tool
As willingly as any singing bird
Sets him to sing his morning roundelay,
Because he likes to sing and likes the song.

. . .

"And for my fame—when any master holds
'Twixt chin and hand a violin of mine,
He will be glad that Stradivari lived,
Made violins, and made them of the best.
The masters only know whose work is good:
They will choose mine, and while God gives them skill
I give them instruments to play upon,
God choosing me to help Him.

. . .

"I say, not God Himself can make man's best
Without best men to help Him. I am one best
Here in Cremona, using sunlight well
To fashion finest maple till it serves
More cunningly than throats for harmony.
'Tis rare delight: I would not change my skill
To be the Emperor.

. . .

" 'Tis God gives skill
But not without men's hands: He could not make
Antonio Stradivari's violins
Without Antonio."

George Eliot

Exercises for Study and Review

(1) Draw a simple map of a lumber camp indicating the timber, buildings, roads, and skidways.

(2) How are trees cut down?

(3) What do the swampers do?

(4) Why is the life of a lumberjack hazardous?

(5) What is meant by a *jam?* How are jams sometimes broken?

(6) Why are logs allowed to lie in the water until they are about to be cut into lumber?

(7) What are some of the most important processes in sawmilling?

(8) Explain the picture, "Slooping Logs Down the Mountain" by Charles S. Chapman.

(9) Locate some of the important lumber producing areas of the United States.

(10) Make a freehand working sketch of a window box for flowers.

(11) If you were to become a woodworker, which line of the work would you prefer to follow? Why?

Suggested Reading about Woodworking

Bishop and Keller.—*Industry and Trade* (Index under *Sawmills*). Ginn & Co.

Blackburn.—*Problems in Farm Woodwork.* Manual Arts Press.

Bush and Bush.—*Industrial and Applied Art Books*, V, VI, VII, VIII. Atkinson, Mentzer, & Company.

Carpenter.—*Geographical Reader*, Book One (Pages 198 to 205, *Lumber*). American Book Company.

Chamberlain.—*How We Are Sheltered* (Page 89, *Lumbering*). The Macmillan Company.

McMurry.—*Type Studies from United States Geography* (Pages 108 and 132, *Lumbering*). The Macmillan Company.

Moseley.—*Trees, Stars, and Birds* (Index under *Furniture, Oak, Pine, Whitewood*). World Book Company.

Noyes.—*Handwork in Wood.* Manual Arts Press.

—— *Wood and Forest.* Manual Arts Press.

Park.—*Educational Woodworking for School and Home.* The Macmillan Company.

Rodgers and Others.—*Trade Foundations* (Index under *Carpenter, Cabinetmaker, Wood*). G. M. Jones, Indianapolis.

Snow and Froehlich.—*Industrial Art Text Books*, V, VI, VII, VIII. The Prang Company.

Tarr and McMurry.—*New Geographies*, Second Book (Index under *Forest Products, Mahogany*). The Macmillan Company.

Toothaker.—*Commercial Raw Materials.* Ginn & Co.

Wells.—*How the Present Came from the Past*, Book Two (Index under *Carpenters, Cabinetmakers, Furniture, Guitars*). The Macmillan Company.

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